Industrial Ethernet Managed Switch

Software User Manual

Version 5.0

Revision 2.0

www.sixnet.com

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Product Information

Products Covered in This Manual

This manual applies to firmware v5.0 in the following products:

- SLX-5MS-# Slim Line Managed Ethernet switch with 5 10/100 ports
- SLX-5MS-MDM-# Managed Ethernet switch with 5 10/100 ports and integrated modem
- SLX-8MS-# Slim Line Managed Ethernet switch with 8 10/100 ports
- SLX-8MG Slim Line Managed Ethernet switch with 8 10/100/1000 ports
- SLX-10MG Managed Ethernet switch with 7 10/100 and 3 Gigabit ports
- SLX-16MS Managed Ethernet switch with 16 10/100 ports
- SLX-18MG Managed Ethernet switch with 16 10/100 and 2 Gigabit ports
- EK26 Rack Mount Gigabit Managed Ethernet switch with 26 ports
- EF26 Rack Mount Managed Ethernet switch with 26 10/100 ports
- EK32 Rack Mount Gigabit Managed Ethernet switch with 32 ports
- EF32 Rack Mount Managed Ethernet switch with 32 10/100 ports
- ET-5MS-OEM -# - 5 port OEM managed switch
- ET-8MS-OEM -# - 8 port PC104 OEM managed switch
- ET-8MS-MIL Military IP67 Managed Ethernet Switch with 8 10/100 ports
- ET-8MG-MIL Military IP67 Managed Ethernet Switch with 8 10/100 ports

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Download the latest firmware from the web site: http://www.sixnet.com Read the firmware release history on the web site: http://www.sixnet.com

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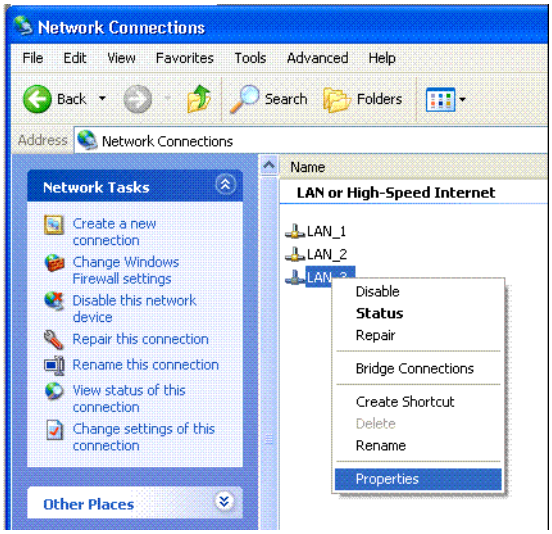
Chapter 1 Accessing the Setup Interfaces

1.1 Quick Start Guide to Web User Interface

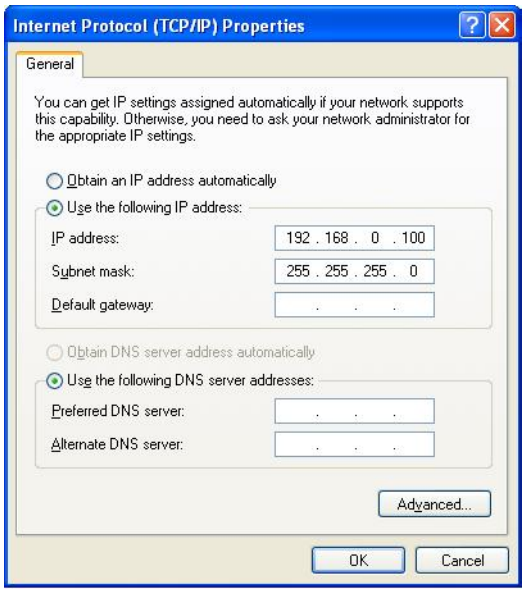
Use this guide to quickly configure the switch over an Ethernet connection.

Note: This is the recommended method for initially accessing the switch.

1. The default IP address and subnet mask of the switch is 192.168.0.1 and 255.255.255.0. This means your PC must be temporarily set to a compatible IP address (example: 192.168.0.100). Follow these directions to do so:
    1. Unplug your computer from your Local Area Network (LAN).
    2. Go to the Control Panel on your computer.
    3. Go to Network Connections.



    4. Access the Properties window for your LAN.
    5. Access the Properties for your Internet Protocol (TCP/IP).
    6. Select “Use the following IP address” and enter an IP of 192.168.0.100 and a subnet of 255.255.255.0.

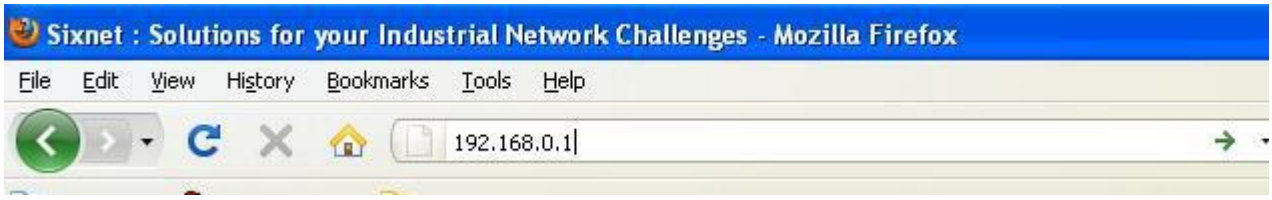


7. Select OK to activate the change. Reboot your PC if prompted.

2. Connect an Ethernet patch cable between your PC and any of the RJ45 Ethernet ports on the switch.

3. To access the switch use a web browser program such as Internet Explorer, Mozilla Firefox, or other.

4. Type the switches default IP address 192.168.0.1 in the web browser's address bar and hit enter on your keyboard.



5. A log in window will open prompting you for a login name and password. Enter '**admin**' for the login and '**admin**' for the password.

6. Read the Software License Agreement and Click the “I accept the License” button.

7. Navigate through the configuration screens using the tree on the left hand side.

8. Selecting **Quick Setup** brings up the **System Settings** menu. This menu is used to configure the IP address (DHCP or static), subnet mask, redundancy protocol, system name, contact, and location information. See the image below.

9. Set the desired IP address and subnet that are compatible with the network for which this switch will reside, or you can enable DHCP. Select Commit to activate your new settings.
10. Restore your PC back to its normal network settings (IP and subnet) and reconnect it to your LAN.
11. Connect the switch to your LAN or the network it will reside and now you can use the IP address you just assigned to access your switch. If you enabled DHCP then you will need to contact your LAN administrator to determine the IP address that was assigned.
12. Once you regain access to your switch then you can do the following:
    a. The default administrative password can be changed from the Remote Access Security menu.
    b. The individual ports on the switch are configured to a set of defaults and auto-selects that should get you started quickly with no necessary configuration. Customizing the port settings by enabling/disabling a port, choosing the speed, duplex, or flow control is accessed from the Port Configuration menu.
    c. The Rapid Spanning Tree Protocol (RSTP) is disabled by default in the switch. The RSTP settings can be changed from the from Redundancy Settings screens.
    d. Check the operational status of the switch by accessing the Monitoring menu.
    e. The modem and PPP settings are found in the Remote Access Settings menu.

    Note: The switch can also be initially configured using the serial port. However, the Ethernet method described above is recommended. Refer to Appendix J if you wish to use the serial port method.

1.2 USB Driver Installation

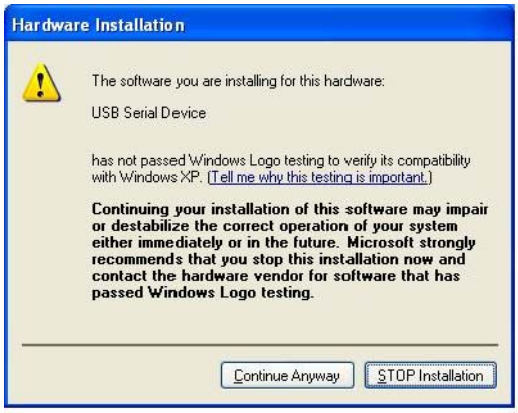
Sixnet managed switches are equipped with both a USB port and an RS232 port for terminal access. In order to take advantage of the USB port, please visit www.sixnet.com or browse your Sixnet CD to install the USB driver.

After completing the installation, you may then connect the switch via USB. The New Hardware Wizard will appear:

Select “No, not this time” and click Next.

On the next screen, select “Install the software automatically”, and click Next.

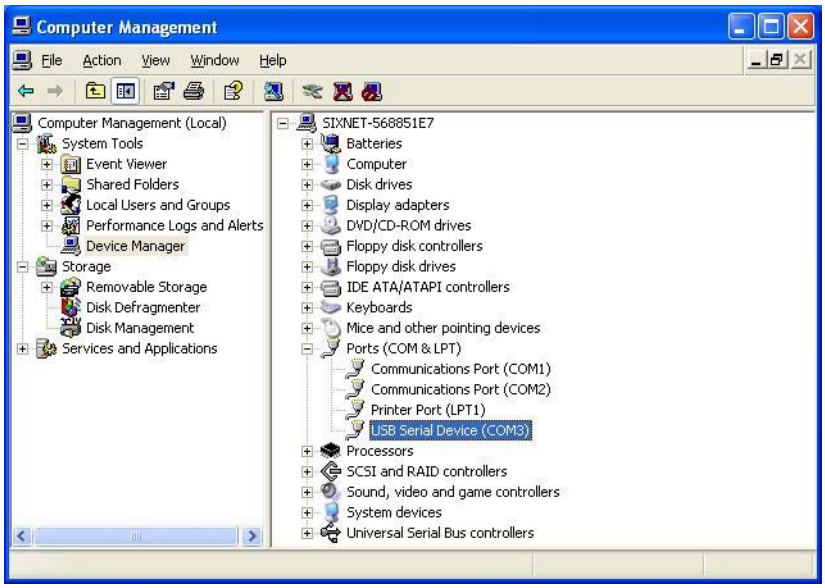
The computer will locate the driver and confirm that you would like to install the unverified driver. Select “Continue Anyway” and click finish to complete the installation.



Note: USB Driver installation is for Windows XP only. Please contact Sixnet for assistance with Windows Vista.

1.3 View the USB COM Port

To view the COM port the USB device has been assigned to, open the Windows Device Manager. Expand the section for Ports (COM & LPT) and locate the port labeled “USB Serial Device”.



The COM number following the name can now be used to access the switch using the terminal interface.

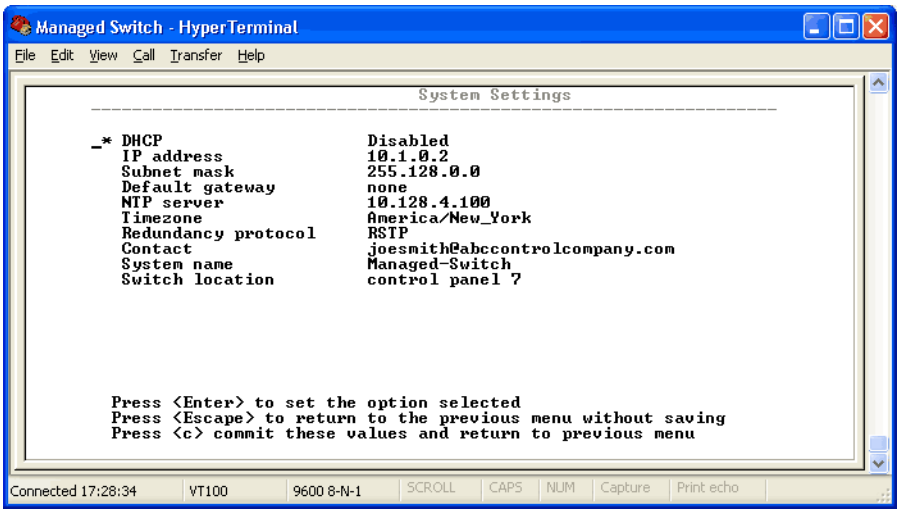
The USB and RS232 ports cannot be connected simultaneously. Please connect only the cable type you wish to use to communicate with the switch.

1.4 Quick Start Guide to Terminal User Interface

As an alternative to the web interface, you can use this guide to quickly configure the switch through the RS232 Port or the USB Port.

Note: This interface is for more advanced users. Using the Web interface described in the beginning of this manual is the recommended method.

1. Connect the serial port of your PC (typically a female DB9 connector) to the serial port of the switch (female RJ45 connector) or on units with a USB port, connect a USB cable from a USB port on your PC to the USB port on the Switch. Refer to the hardware user manual for details on how to make this connection. Contact your switch provider to purchase a pre-wired interface cable or USB cable if necessary.
2. Configure a terminal program (such as HyperTerminal) for 9600, 8N1 and no flow control. See Section further below for more details.
3. Type 'admin' for the login name and 'admin' for the password.
4. Choose the appropriate terminal emulation setting that is supported by your terminal program.
5. Navigation of the character interface is done by using the arrow keys to highlight the option, the Enter key to select, and the Escape key to go back to the previous menu. Pressing ‘c’ will commit the changes. Press ‘x’ from the main menu to logout.
6. Selecting Quick Setup brings up the System Settings menu. This menu is used to configure the IP address (DHCP or static), subnet mask, redundancy protocol, system name, contact, and location information.



7. Set the desired IP address and subnet that are compatible with the network for which this switch will reside, or you can enable DHCP. Select “c” to activate your new settings.
8. Now you can access the switch via the web interface or you can continue to make configuration changes using this text interface.
9. Using the text interface you can do the following:
    1. The default administrative password can be changed from the Remote Access Security menu.
    2. The individual ports on the switch are configured to a set of defaults and auto-selects that should get you started quickly with no necessary configuration. Customizing the port settings by enabling/disabling a port, choosing the speed, duplex, or flow control is accessed from the Port Configuration menu.
    3. The Rapid Spanning Tree Protocol (RSTP) is disabled by default in the switch. The RSTP settings can be changed from the from Redundancy Settings screens.
    4. Check the operational status of the switch by accessing the Monitoring menu.
    5. The modem and PPP settings are found in the Remote Access Settings menu.

1.5 Using Microsoft HyperTerminal

Configure Microsoft Windows HyperTerminal for use with the switch as follows:

1. Create a new connection by choosing New Connection from the File menu.
2. In the Connection Description dialog, give the connection a name such as “Managed Switch” and click OK.
3. In the Connect To dialog, choose the correct COM port.
4. In the COM Properties dialog, choose the following settings:

- 9600 bits per second (Bps or Baud)
- 8 data bits, no parity, 1 stop bit
- no flow control.

5. Click OK.
6. Open the Connection Properties dialog by choosing Properties from the File menu.
7. Click on Settings to raise the setting tab.
8. Select VT100 from the Emulation list.
9. Click Terminal Setup.
10. In Terminal Settings, check Cursor keypad mode & hit OK.
11. Click OK to close the Connection Properties dialog.

Once the terminal screen comes up the switch prompts for a login name. It may be necessary to press Enter once or twice to see the login prompt. The default login user and password are both 'admin'. After the login and password prompts, select VT100 by pressing 4 and then Enter The main administrative menu will now appear and the managed switch is now ready for full configuration.

Chapter 2 Initial Setup and Configuration

2.1 Overview

The Industrial Ethernet Managed Switch is a configurable device that facilitates the interconnection of Ethernet devices on an Ethernet network. This includes computers, operator interfaces, I/O, controllers, RTUs, PLCs, other switches/hubs or any device that supports the standard IEEE 802.3 protocol. This switch has all the capabilities of a store and forward Ethernet switch plus advanced management features such as SNMP, RSTP and port mirroring. This manual details how to configure the various management parameters in this easy to use switch.

2.2 Introduction

To take full advantage of all the features and resources available from the switch, it must be configured for your network.

The switch implements Rapid Spanning Tree Protocol (RSTP) and Simple Network Management Protocol (SNMP) to provide most of the services offered by the switch. Rapid Spanning Tree Protocol allows managed switches to communicate with each other to ensure that there exists only one active route between each pair of network nodes and provides automatic failover to the next available redundant route. A brief explanation of how RSTP works is given in the Spanning Tree section.

The switch is capable of communicating with other SNMP capable devices on the network to exchange management information. This statistical/derived information from the network is saved in the Management Information Base (MIB) of the switch. The MIB is divided into several different information storage groups. These groups will be elaborated in detail in the Management and SNMP information section of this document.

The switch implements Internet Group Management Protocol (IGMP) to optimize the flow of multicast traffic on your network.

The switch supports both port-based and tag-based Virtual LANs for flexible integration with VLAN-aware networks with support for VLAN-unaware devices.

Additional technical documentation is available in the appendices of this manual. These appendices provide important terminology/definitions, an administrative menu map, example of an RSTP network topology, and factory default information extracted from the switch.

2.3 Administrative Interface Access

There are several administrative interfaces to the switch:

1. A graphical **web interface** accessible via the switch's built-in web server. Both http and secure https with SSL are supported. (Note: This is the recommended method for managing the switch.)
2. A **terminal interface** via the RS232/USB port or over the network using telnet or Secure Shell (SSH).
3. An **SNMP interface** can be used to read/write many settings.
4. **CLI (Command Line Interface)** can be used to read/write most settings. See the separate CLI User Manual for details.

Initial setup must be done using an Ethernet connection (recommended) or the serial port. See Section 1 for quick start guides.

2.3.1 Using the Graphical (Web) Interface

The graphical interface is provided via a web server in the switch and can be accessed via a web browser such as Opera, Mozilla, or Internet Explorer.

Note: JavaScript must be supported and enabled in your browser for the graphical interface to work correctly.

HTTP and HTTPS (secure HTTP) are supported for access to the web server. By default, both protocols are enabled. Either or both may be disabled to secure the switch. (See the Remote Access Security topic in this section.)

To access the graphical interface, enter a URL like **HTTP://192.168.0.1** in your browser's address bar. Replace “http” with “https” to use secure http and replace “192.168.0.1” with your switch's IP address if you've changed it from the factory default.

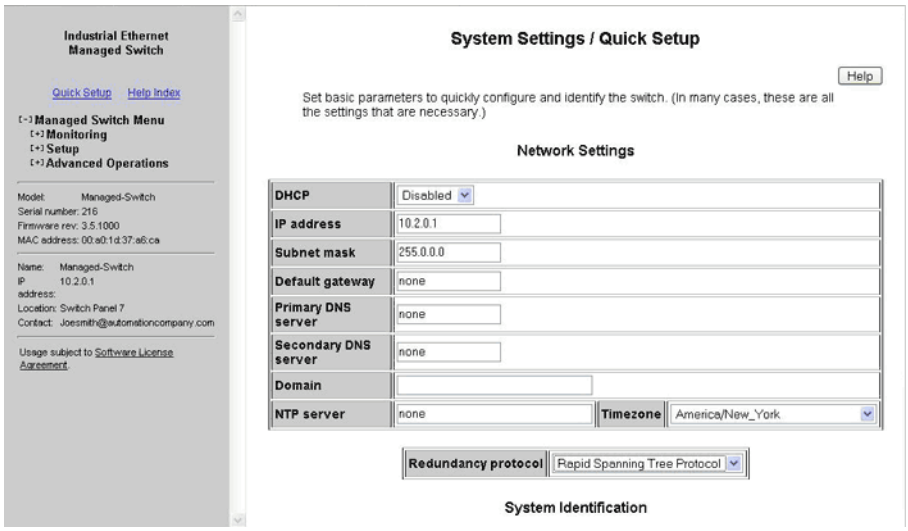
The web server in the switch uses a signed security certificate. When you access the server via https, you may see a warning dialog indicating that the certificate was signed by an unknown authority. This is expected and to avoid this message in the future you can choose to install the certificate on your computer.

Note: This manual describes and depicts the web user interface in detail. The terminal interface is not specifically shown but is basically the same.

2.4 Configuring the Switch for Network Access

To control and monitor the switch via the network, it must be configured with basic network settings, including an IP address and subnet mask. Refer to the quick start guide in Section 1 for how to initially access your switch.

To configure the switch for network access, select **Quick Setup** from the **Main Menu** to reach the **System Settings** menu. The settings in this menu control the switch's general network configuration.



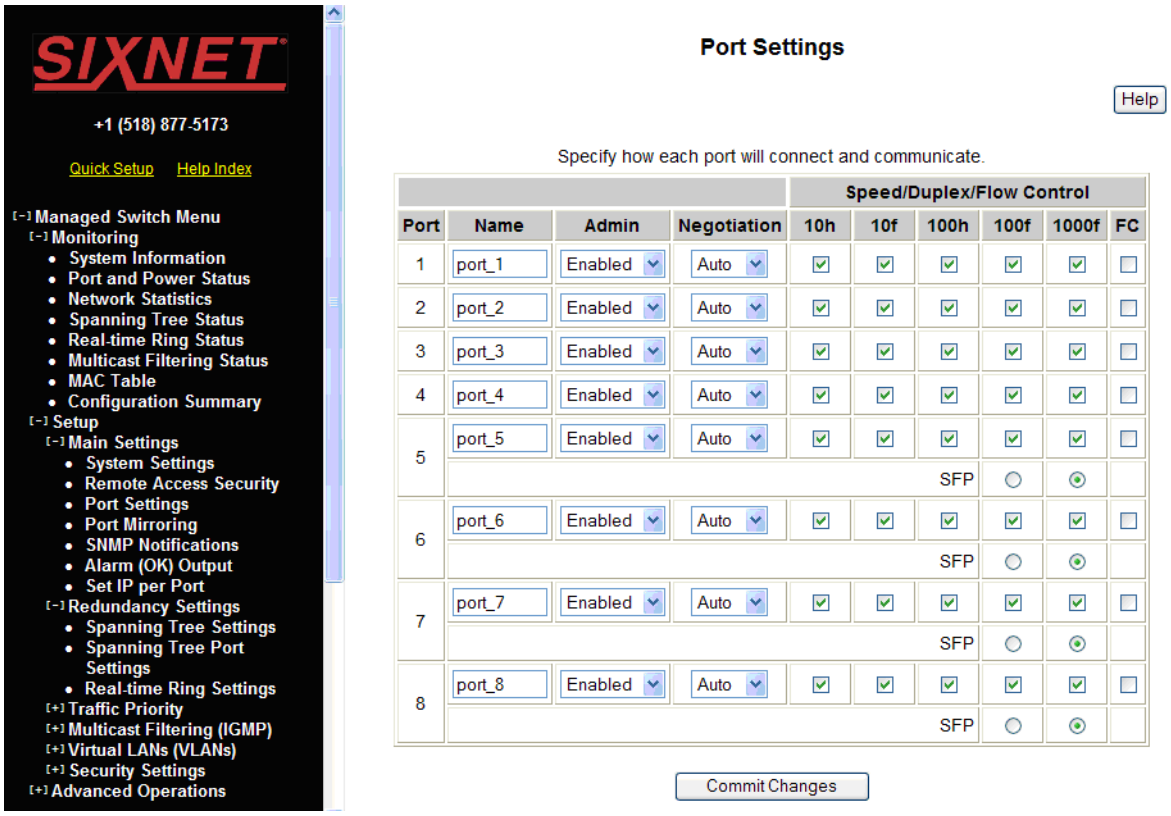
- **DHCP Enabled/Disabled**: The switch can automatically obtain an IP address from a server using the Dynamic Host Configuration Protocol (DHCP). This can speed up initial set up, as the network administrator does not have to find an open IP address.
- **IP Address and Subnet Mask Configuration**: The IP address for the switch can be changed to a user-defined address along with a customized subnet mask to separate subnets.

Note: Advanced users can set the IP address to 0.0.0.0 to disable the use of an IP address for additional security. However, any features requiring an IP address (i.e., web interface, etc.) will no longer be available.

- **Default Gateway Selection**: A Gateway Address is chosen to be the address of a router that connects two different networks. This can be an IP address or a Fully Qualified Domain Name (FQDN) such as “domainname.org”.
- **NTP Server**: The IP address or domain name of an NTP (Network Time Protocol) server from which the switch may retrieve the current time at startup. Please note that using a domain name requires that at least one domain name server be configured. See Chapter 11 Other Special Features on page 105 for more details.

2.5 Configuring the Ethernet Ports

The switch comes with default port settings that should allow you to connect to the Ethernet Ports with out any necessary configuration. Should there be a need to change the name of the ports, negotiation settings or flow control settings, you can do this in the **Port Configuration** menu. Access this menu by selecting **Setup** from the **Main** menu, and then selecting **Main Settings**.



- **Port Name**: Each port in the managed switch can be identified with a custom name. Specify a name for each port here.
- **Admin**: Ports can be enabled or disabled in the managed switch. For ports that are disabled, they are virtually non-existent (not visible in terms of switch operation or spanning tree algorithm). Choose to enable or disable a port by selecting Enabled or Disabled, respectively.
- **Negotiation**: All copper ports and gigabit fiber ports in the managed switch are capable of auto-negotiation such that the fastest bandwidth is selected. Choose to enable auto-negotiation or use fixed settings. 100Mbps Fiber ports are Fixed speed only.
- **Speed/Duplex/Flow Control**: The managed switch accepts three local area network Ethernet Standards. The first standard, 10BASE-T, runs 10Mbps with twisted pair Ethernet cable between network interfaces. The second local area network standard is 100BASE-T, which runs at 100Mbps over the same twisted pair Ethernet cable. Lastly, there is 100BASE-F, which enables fast Ethernet (100Mbps) over fiber.

  These options are available:

  - 10h–10 Mbps, Half Duplex
  - 10f –10 Mbps, Full Duplex
  - 100h–100 Mbps, Half Duplex
  - 100f –100 Mbps, Full Duplex
  - 1000f–1000 Mbps, Full Duplex

On managed switches with gigabit combination ports, those ports with have two rows, a standard row of check boxes and a row labeled “SFP” with radio buttons. The SFP setting independently sets the

speed at which a transceiver will operate if one is plugged in. Otherwise, the switch will use the fixed Ethernet port and the corresponding settings for it.

Note: When 100F is selected for the SFP of a gigabit combination port, the corresponding fixed Ethernet jack will be disabled unless it is changed back to 1000F.

Flow control can also be enabled or disabled, and is indicated by 'FC' when enabled. Devices use flow control to ensure that the receiving devices takes in all the data without error. If the transmitting device sends at a faster rate than the receiving device, than the receiving device will eventually have its buffer full. No further information can be taken when the buffer is full, so a flow control signal is sent to the transmitting device to temporarily stop the flow of incoming data.

Chapter 3 Configuration Management and Firmware Updates

3.1 Installing Firmware

The Install Firmware page allows the inactive firmware to be replaced with a new version.

3.1.1 Installing from the Local System

Firmware may be directly uploaded to the switch from the local system. Use the "Browse..." button to locate the **.fwb** firmware file. If an MD5 checksum of the file is available, it may be entered into the **MD5 Checksum (Optional)** field. Providing a checksum will ensure the firmware arrives at the switch intact and without any glitches. An MD5 checksum is not required. Click the **Install from file** button to begin the firmware installation process.

3.1.2 Installing from a Remote Server

Firmware may be fetched by the switch from a remote machine serving the **.fwb** firmware file. The server must be providing the file via TFTP, HTTP, HTTPS, FTP, or FTPS.

Enter the address of the server in the **Server Address** field. This may be an IP address, or a domain name if a DNS server has been configured on the **System Settings** page. Literal IPv6 addresses must be surrounded with square brackets.

For example, to use the address:

```
fdda:2301::2
```

enter it as:

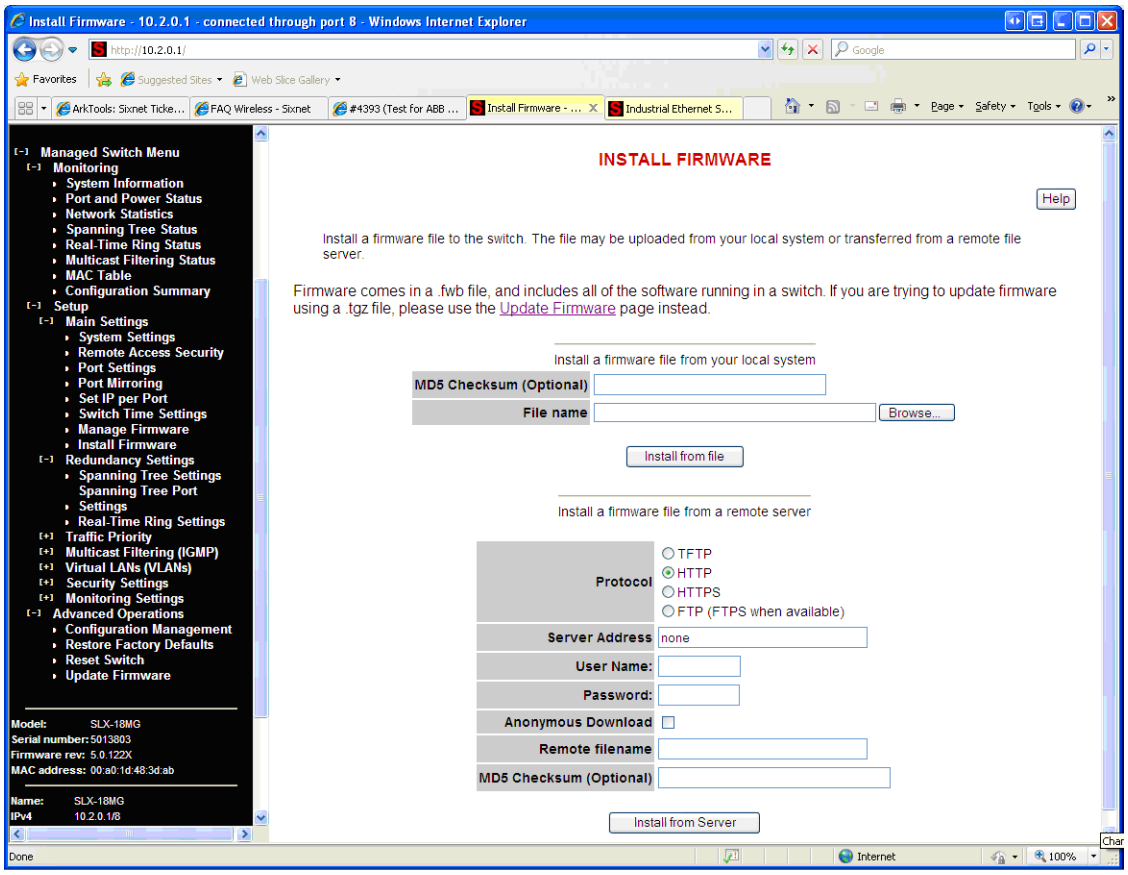
```
[fdda:2301::2]
```

If the server requires a user name and password to retrieve files (not available for TFTP), enter those credentials in the **User Name** and **Password fields**, respectively. If the server does not require this kind of authentication and will allow anybody to download files, check the **Anonymous Download** box instead.

Enter the full path to the file on the server in the **Remote filename** field.

If an MD5 checksum is available for the file, it may be provided in the **MD5 Checksum (Optional)** field. Providing a checksum will ensure that the file is received intact and without any glitches. An MD5 checksum is not required.

Click on the **Update from Server** button to begin the firmware installation process.



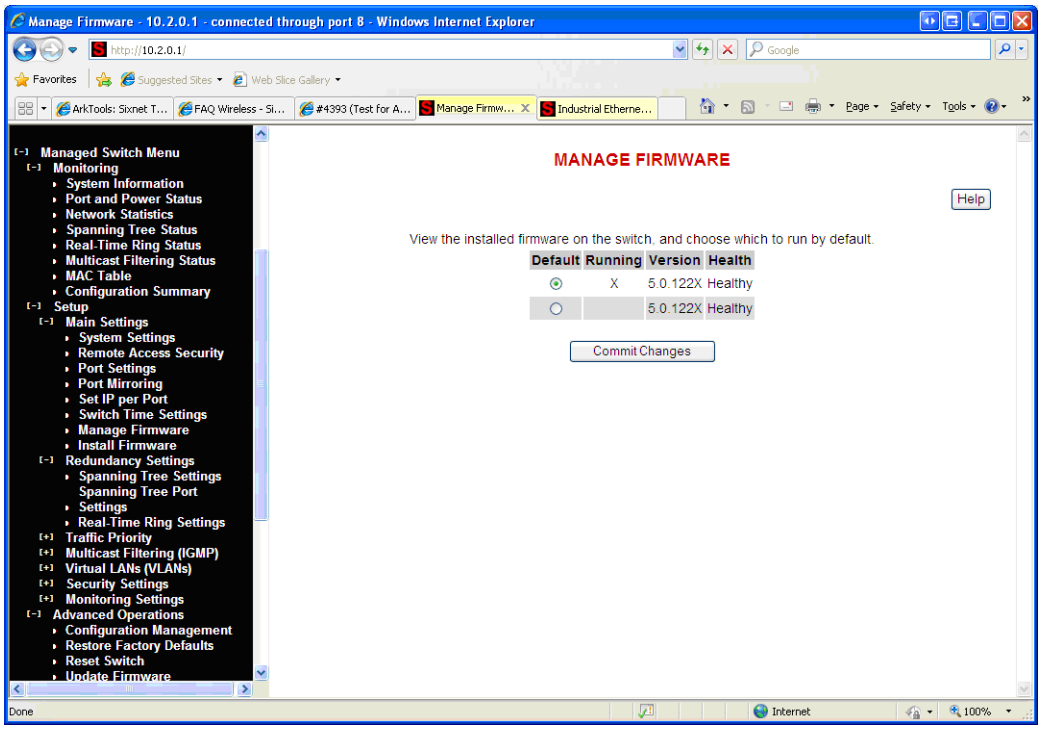
3.2 Managing Firmware

The Manage Firmware page displays the current status of each of the two firmware images on a switch, and allows for changing which one will run the next time the switch is reset.

- **Default**–Shows the current default firmware image to run when the switch is reset. May be changed to run a different firmware on the next reset.
- **Running**–Shows the current running firmware image. This may be different from the current default firmware image if the switch failed to boot recently.
- **Version**–Displays the firmware version number for each installed firmware. If the version cannot be determined, this will report “Unknown”.
- **Health**–Shows the health of each firmware image. The health can be one of the following:

- **Healthy**–The firmware is running or is expected to be in good enough shape to run.
- **Broken**–The firmware is known to be in a state that would prevent it from booting. The **Default** column will not allow this image to be selected for booting.
- **Unknown**–The firmware may be bootable, but the switch cannot be certain. This will happen if the switch is running the non-default firmware. This can happen if the default firmware somehow became corrupt, or if the switch lost power part way through booting.

If the firmware that is currently running is not the default, and the switch is reset without explicitly saving the default, the current firmware will be run again. To boot the firmware marked as the default, commit this page without making any changes and then reset the switch.



3.3 Advanced Operations

Use the Advanced Operations Menu for saving and restoring configurations, reloading factory defaults, resetting the switch, updating the firmware, and setting up remote access.

Note: The web interface supports direct transfers to and from the system where your browser is running. Alternatively, you can use TFTP (Trivial File Transfer Protocol) for file transfers.

Access to the Advanced Operations menu is available by selecting the option in the Main menu.

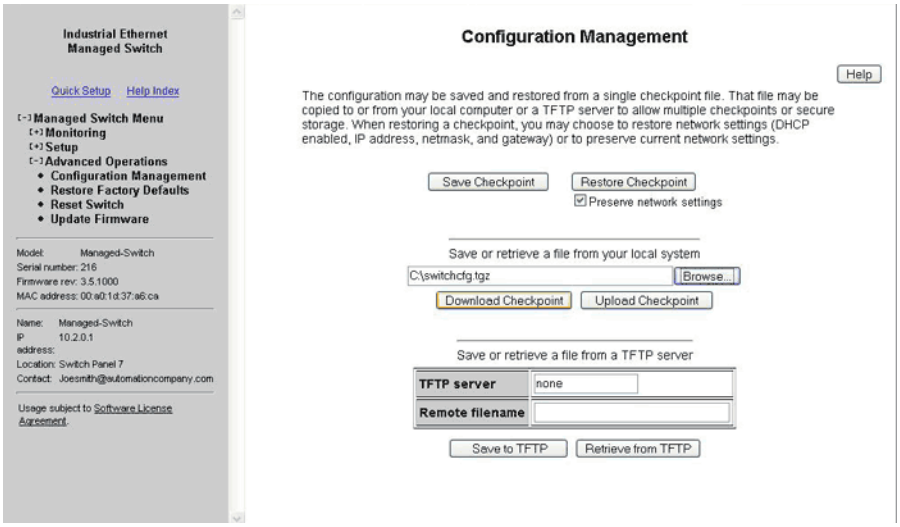
3.3.1 Saving and Retrieving Files

The **Configuration Management** and **Update Firmware** features allow you to Browse to save and retrieve files directly from your local system. This is the easiest and recommended method. Alternatively, you can use a TFTP (Trivial File Transfer Protocol) server to centralize the storage of your con-

figuration and firmware files. Free TFTP servers for Windows and Linux are available on the web. They are generally easy to install and setup.

3.4 Configuration Management

One “checkpoint” (backup) version of the switch's configuration can be stored in a local file on the switch. Unlimited backups can also be saved to your local system (web interface only) or to a TFTP server elsewhere on the network.



- **Save Checkpoint**: Saves a checkpoint configuration in the switch, which may be used later to revert back to the current state if changes lead to an undesirable configuration.
- **Restore Checkpoint**: Reverts to the settings in the saved checkpoint. You can optionally choose to keep your current network settings or use the ones in the checkpoint file.

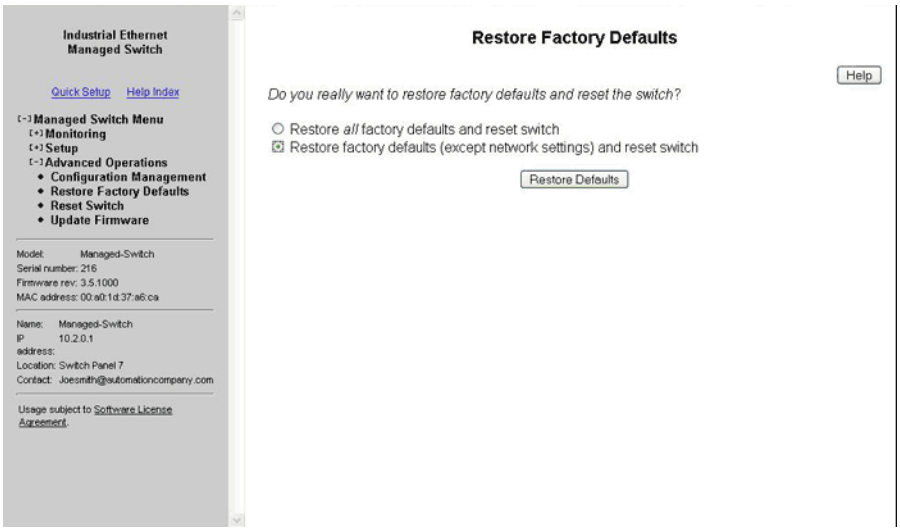
Note: The current administrator's password will remain in effect after the restoration. SNMP passwords will be restored to the values in the checkpoint.

- **TFTP Configuration**: Specifies the name or IP address of the TFTP (Trivial File Transfer Protocol) server where configuration checkpoints may be stored.
- **Save to TFTP**: Saves the current configuration checkpoint file to the defined TFTP server. You must specify the name of a file on the server.
- **Retrieve from TFTP**: Retrieves a previously saved configuration checkpoint file from the defined TFTP server. After retrieval, the configuration still must be restored to be made active.

Note: The web interface also allows you to download (save) and upload (retrieve) files directly from your local system. No TFTP server is needed.

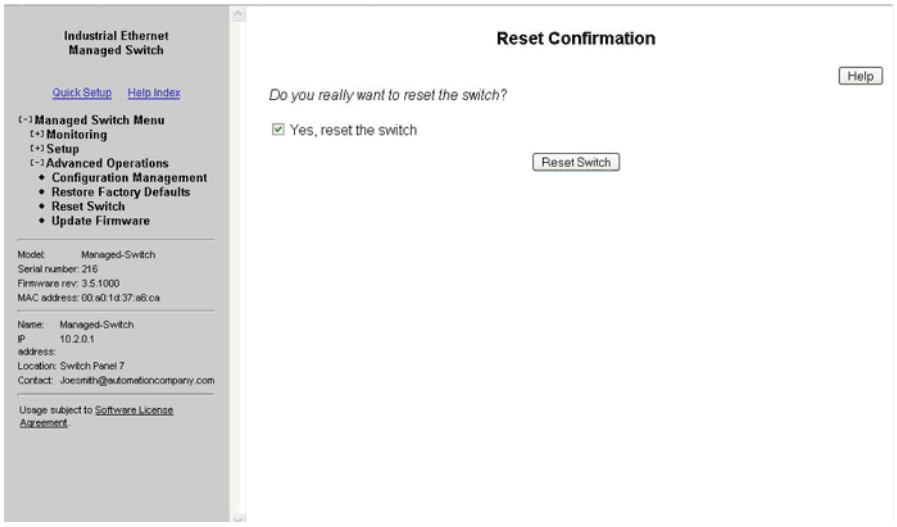
3.5 Factory Defaults

This option sets the switch back to factory default settings. The switch will automatically restart (reset) to put the default settings into effect.



3.6 Reset Switch

This feature will cause the switch to perform a “soft” restart (software reset). A software reset may take 30 seconds or more depending on what features are enabled in the switch.



3.7 Update Firmware Using the Web Interface

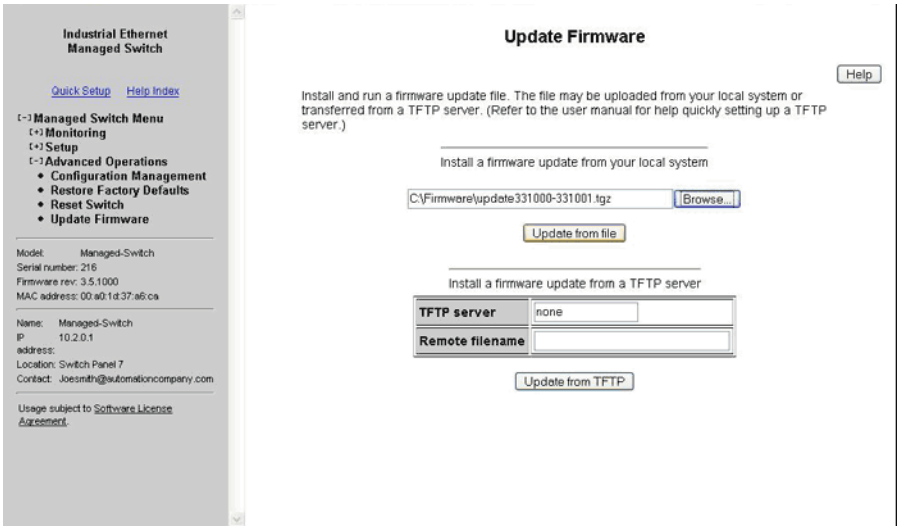
Firmware updates are released periodically to add features and fix problems. The recommended and easiest way to update firmware is from the web interface. It allows you to Browse and select the firmware update package from your local computer or a computer on your local network. Then just click the Update from File button to load and install the latest firmware files.

This method of updating the firmware will retain all your settings. However, it is still recommended that you save a “checkpoint” configuration as a backup.

3.8 Update Firmware Using a TFTP Server

Another option for updating firmware is via a TFTP server elsewhere on the network. Simply specify the IP address of the remote TFTP server and the filename of the update. If necessary, the switch will automatically reboot after installing the new firmware files. After the reboot you may see an “Internal Server Error” message. Simply click refresh on your browser to reestablish communications with the switch.

This method of updating the firmware will retain all your settings. However, it is still recommended that you save a “checkpoint” configuration as a backup.



3.9 Updating Firmware Using the Switch Utility

In the event the switch is not reachable by the web or CLI interfaces, the unit can be recovered and reloaded using the switch utility. This operation will erase all configuration settings and set them to factory defaults.

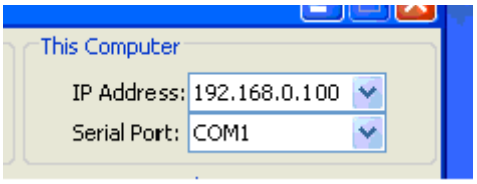
Steps for using the utility to load firmware:

1. Download and install the Switch Utility program. The Java Runtime is required for the switch utility to run, and will be loaded as part of the installation process. You may download the switch utility from www.sixnet.com.
2. Download the latest firmware bundle from www.sixnet.com and save it to the desired location on your PC.
3. Run the Switch Utility from the shortcut on your desktop.

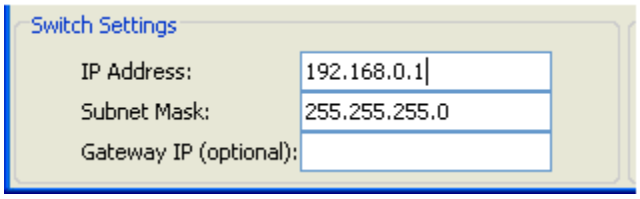
Note: Please ensure that a TFTP service is not running and no other program is using your serial port prior to starting the Switch Utility.

4. From the Switch Utility, browse to the location of the 5.0 firmware bundle and select it.

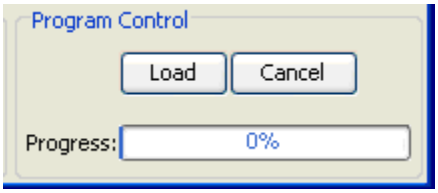
5. Choose the network adapter (by IP address) and serial port you will use to communicate with the switch.



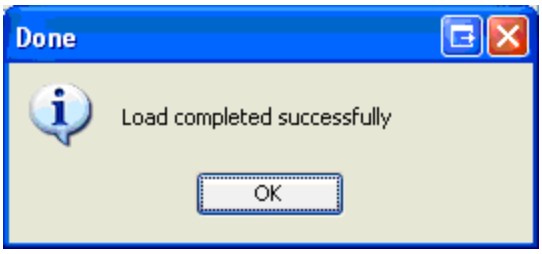
6. Enter the IP address you would like the switch to have once the new firmware has been loaded. Note that the IP address of the switch must be on a compatible subnet of the network adapter you are loading firmware from.



7. Click the **Load** button to begin loading firmware.



When prompted, cycle power to the switch. As the firmware loads, the progress meter should increase to 100%, and a message will confirm that the load was successful.

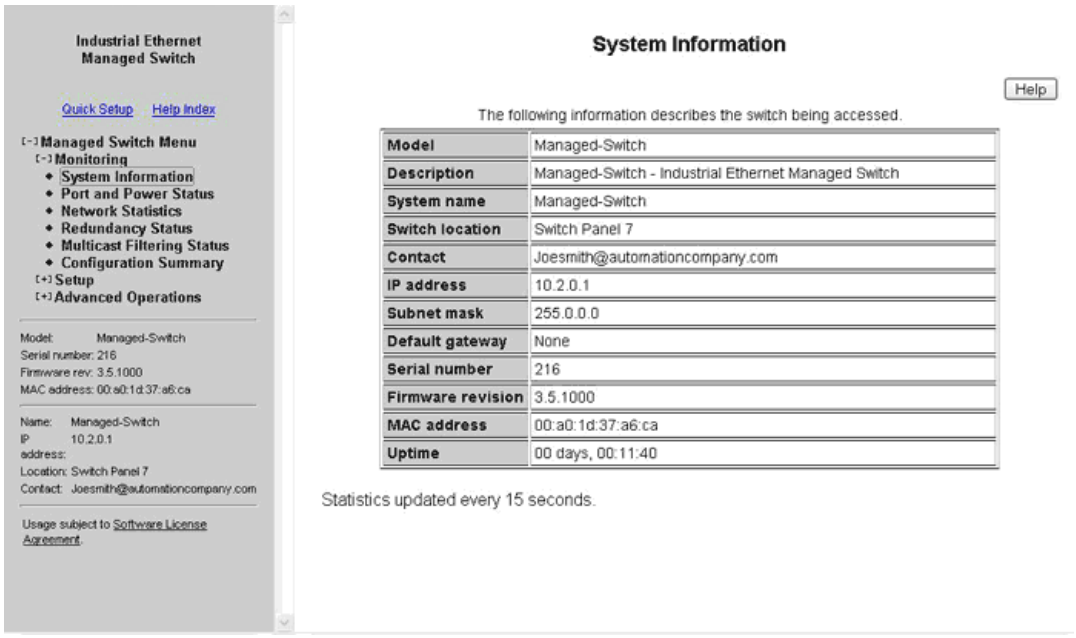


The switch should now be fully accessible at the IP address specified in the Utility.

Chapter 4 Monitoring the Current State of the Switch

4.1 System Information

The System Information page displays identifying information about the switch, and current network settings.



- **Model** number of the switch.
- **Description** is available via SNMP as SYSTEM.SYSDESCR.0. This is the basic description of the switch.
- **System Name**: The hostname of the switch. It must contain only letters, digits, and dashes. This may be read or written via SNMP as SYSTEM.SYSNAME.0.
- **Switch Location**: The physical location of the switch (the cabinet, closet, rack, etc. it is in). This may be read or written via SNMP as SYSTEM.SYSLOCATION.0.

- **Contact**: Typically, this parameter includes the contact's name and e-mail address. This may be read or written via SNMP as SYSTEM.SYSCONTACT.0.
- **IP Address**: IP address of the switch
- **Subnet Mask**: Subnet Mask of the switch. Readable via SNMP as RFC1213-MIB::IPADENT-NETMASK.<IPADDRESS> where <IPADDRESS> is the IP address of the switch (e.g., 10.2.0.1).
- **Gateway**: Gateway IP configured for the switch. Readable via SNMP as RFC1213-MIB::IPROUTENEXTHOP.
- **Serial Number** is a unique serial number assigned to the switch at the factory. This number cannot be set in the user interface.
- **Firmware Revision** is the version of the firmware currently in the switch.
- **MAC Address**: Media Access Control number of the switch (cannot be set).
- **System Up Time** is available via SNMP as SYSTEM.SYSUPTIME.0. This is the amount of time since the switch was last powered up.

4.2 Port Status

The Port Status page displays the current status of each port. The display will be updated every 5 seconds.

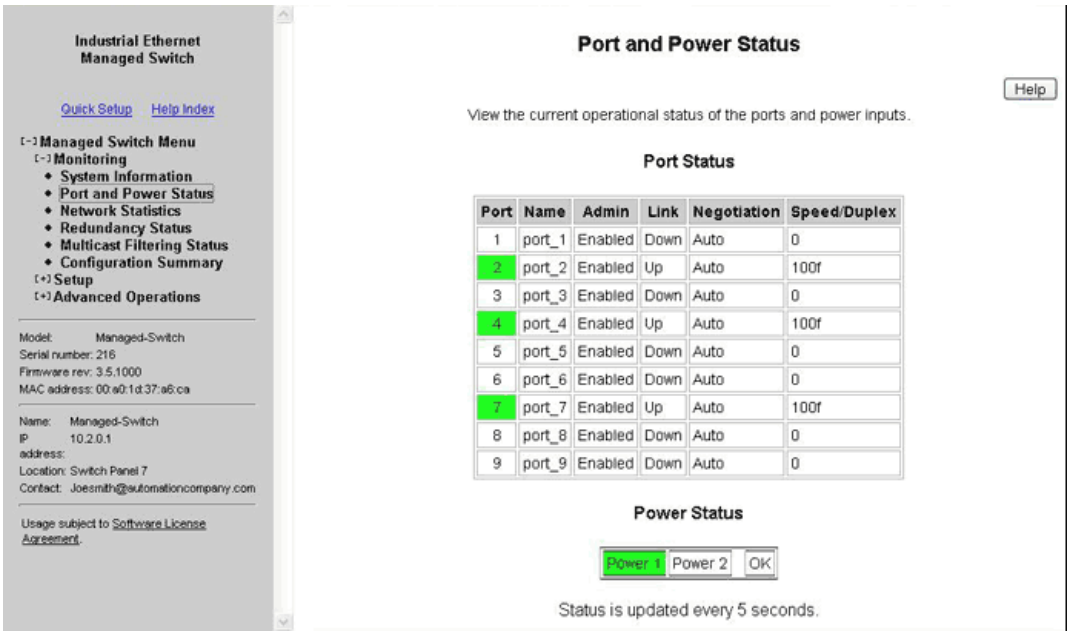
The following information for each port is displayed:

- **Port**: The number of the port. This corresponds to the labels on the switch.
- **Name**: The user-configured name of the port.
- **Admin**: The configured state of the port (enabled or disabled).
- **Link**: The current state of the Ethernet link at a port. If there is a proper connection link status will show Up. If the port is disabled, not connected, or has a faulty connection, the link status will show Down.
- **Negotiation**: Shows whether auto-negotiation is enabled (Auto) or disabled (Fixed).
- **Speed/Duplex:** Shows the speed of the connection (10, 100 or 1000 Mbps) and the duplex status (h = half duplex; f = full duplex).

4.3 Power and OK Status

A separate area below the Port Status grid mimics the P1, P2, and OK status LEDs on the switch. When P1 is highlighted, power is detected on the first terminal input. P2 is highlighted when power is detected on the second terminal input.

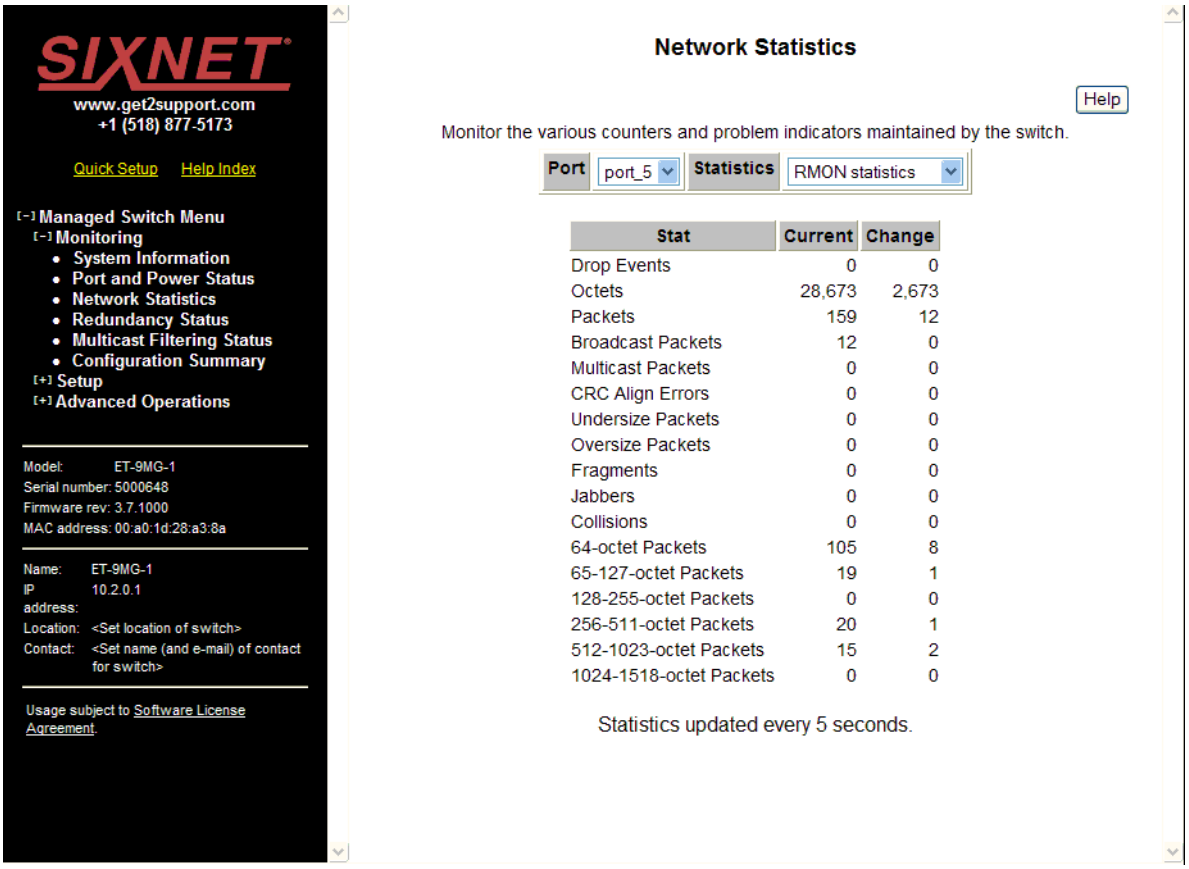
OK (To PLC in the SL-5MS-MDM) is highlighted when power is detected on the first and second terminal inputs and the switch software is running. The OK output can also be configured as an alarm for a broken ring or a lost link on designated port(s).



Port	Name	Admin	Link	Negotiation	Speed/Duplex
1	port_1	Enabled	Down	Auto	0
2	port_2	Enabled	Up	Auto	100f
3	port_3	Enabled	Down	Auto	0
4	port_4	Enabled	Up	Auto	100f
5	port_5	Enabled	Down	Auto	0
6	port_6	Enabled	Down	Auto	0
7	port_7	Enabled	Up	Auto	100f
8	port_8	Enabled	Down	Auto	0
9	port_9	Enabled	Down	Auto	0

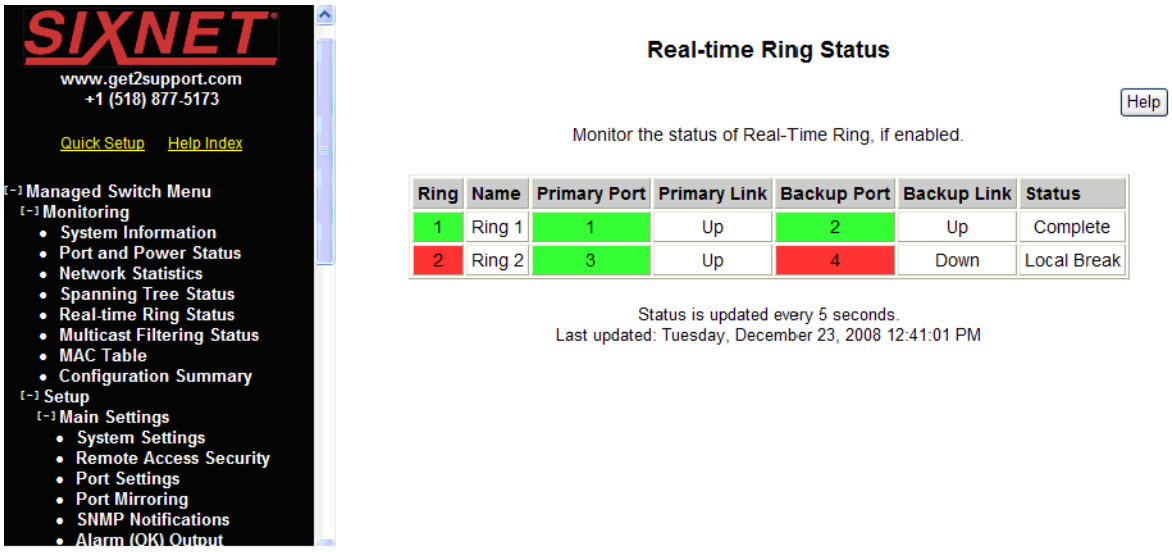
4.4 Network Statistics

The Network Statistics displays network statistics for the selected port. Choose between RMON and Ether-like statistics. The display will be updated every 5 seconds and the change since the last refresh will be displayed in the change column.



4.5 Real-Time Ring Status

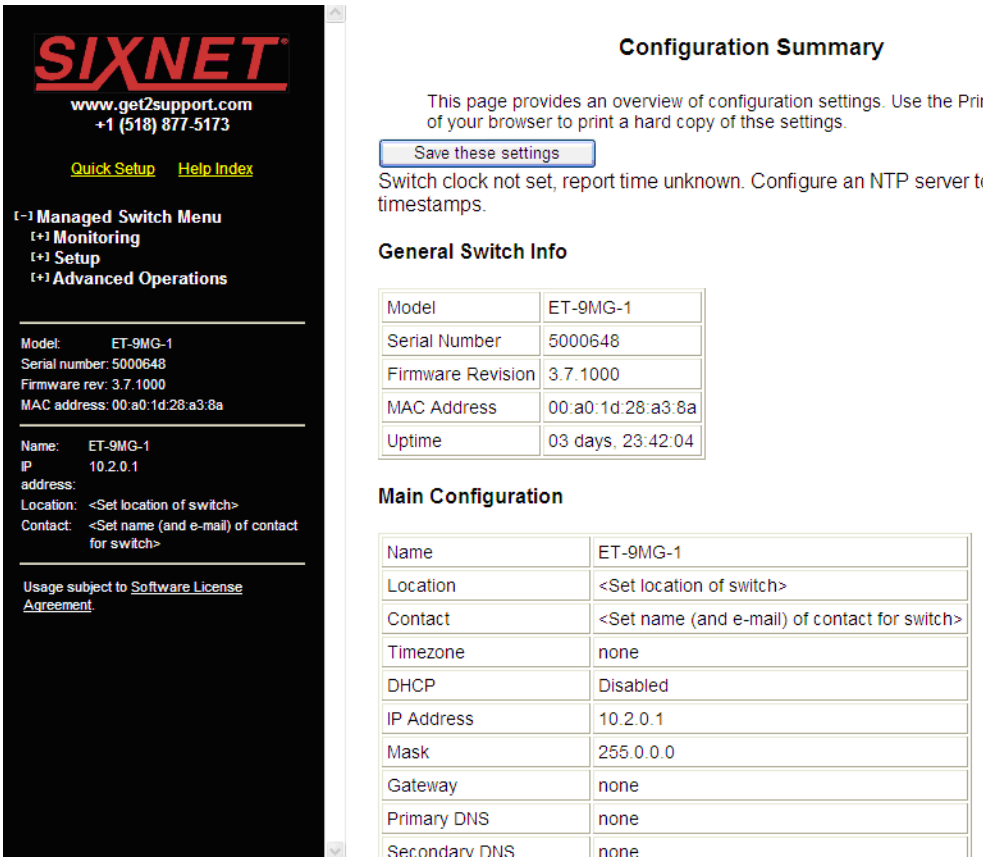
The Real-Time Ring Status page shows the status of the rings configured on the switch, including the status of the primary and backup ports as well as the status of the Real-Time Ring as a whole.



4.6 Configuration Summary

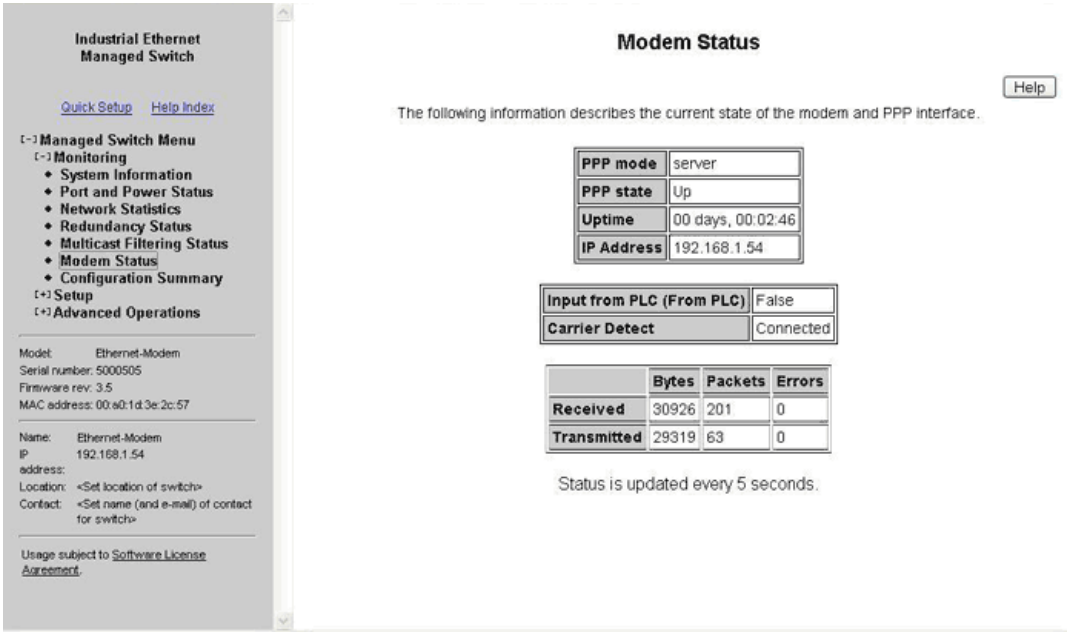
The Configuration Summary Page provides a complete overview of the configuration settings of the switch. The summary is generated in a print-friendly format. If an NTP server is configured, the report will also report a timestamp. To save these settings to a configuration file, click the “Save these settings” button to be redirected to the Configuration Management screen.

Note: This page is for viewing settings only. To change settings, please browse to the individual configuration screens.



4.7 Modem Status

The Modem Status page shows the status and statistics of the PPP connection along with the connected state of the modem. The display will be updated every 5 seconds.



PPP mode: Indicates whether the 5MS-MDM is in Client or Server mode.

PPP state: Current state of the PPP connection - Up or Down.

Uptime: Time the PPP connection has been up. It will be blank if there is no PPP connection.

IP Address: The IP address being used by the PPP connection.

Subnet mask: The Subnet Mask being used by the PPP connection.

Received: The number of Bytes, Packets and Errors that have come in via the PPP connection.

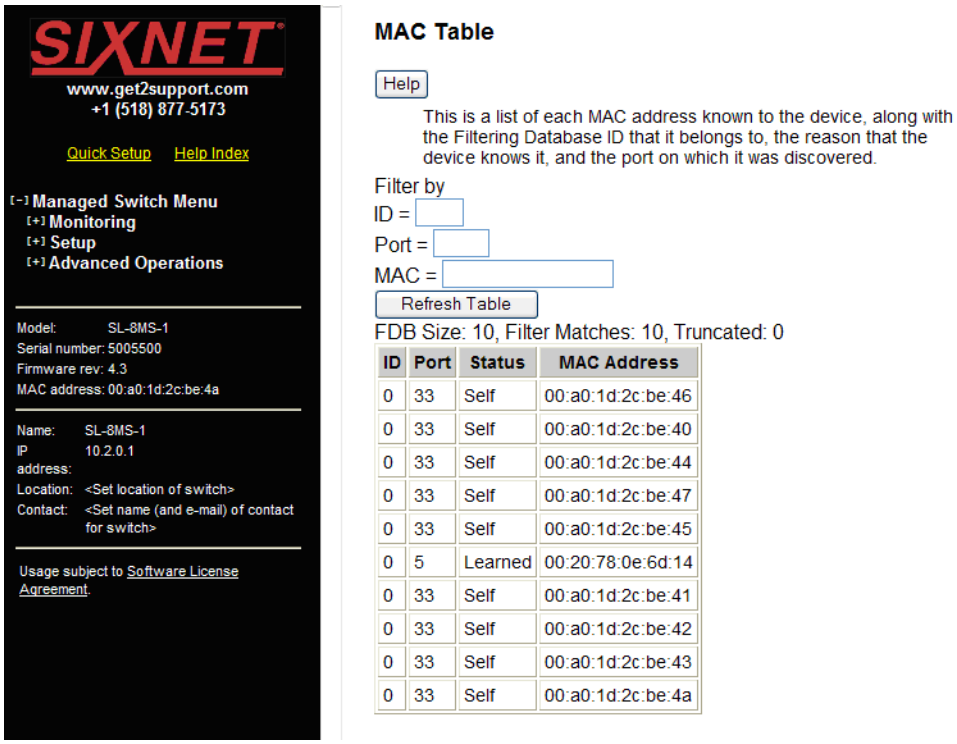
Transmitted: The number of Bytes, Packets and Errors that have been transmitted by the PPP connection.

Input From PLC (From PLC): Status of the 'From PLC' input on the SLX-5MS-MDM. TRUE is displayed when a voltage is detected on the From PLC input. FALSE is displayed when no voltage is detected.

Carrier Detect (CD): Displays the status of the modem connection as either Connected or Disconnected.

4.8 MAC Address Table

The MAC address table page displays the current MAC address table of the switch. This data can be filtered by the Filter Database ID(FID), the port(s) of discovery or by all or part of the MAC address. Please note that Port 33 or 65 is the internal CPU port, depending on the model.



ID	Port	Status	MAC Address
0	33	Self	00:a0:1d:2c:be:46
0	33	Self	00:a0:1d:2c:be:40
0	33	Self	00:a0:1d:2c:be:44
0	33	Self	00:a0:1d:2c:be:47
0	33	Self	00:a0:1d:2c:be:45
0	5	Learned	00:20:78:0e:6d:14
0	33	Self	00:a0:1d:2c:be:41
0	33	Self	00:a0:1d:2c:be:42
0	33	Self	00:a0:1d:2c:be:43
0	33	Self	00:a0:1d:2c:be:4a

4.9 Alarm (OK) Output

These settings control the events that will trigger the alarm output. The OK discrete output is on during normal conditions and turned off in the event of an alarm condition.

4.9.1 Both Power Inputs On

An alarm condition will be triggered if power is not on for both power inputs.

4.9.2 Ring Failure

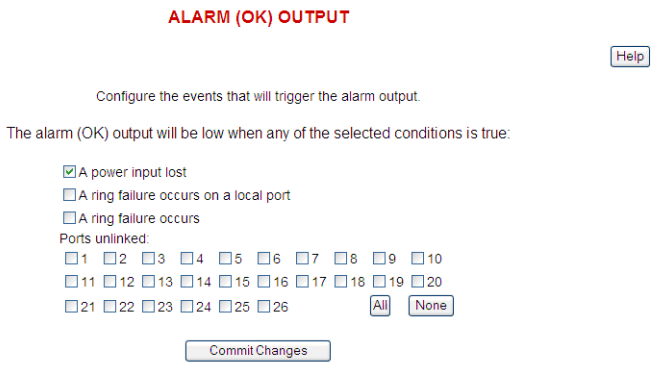
An alarm condition will be triggered when a ring failure occurs.

Ring failure on a local port will be triggered when one of this switch's neighbors in the ring goes down; the general ring failure option will be triggered when any switch in the ring goes down.

The general ring failure option implies that local ring port failure is also detected.

4.9.3 Ports Linked

An alarm condition will be triggered whenever any of the selected ports are not linked.



4.10 Modbus Monitoring

These settings control whether and how the switch will respond to Modbus requests. Modbus registers are available for monitoring link status on each Ethernet port, the power and OK status, and the status of each configured Real-Time Ring.

4.10.1 Enabled

If selected, the switch will respond to Modbus requests.

4.10.2 Station Number

The Modbus station number that the switch will respond as.

4.10.3 Transport Layers

The switch will respond to Modbus requests only on the chosen transport layers.

4.10.4 TCP Timeout

If a new TCP connection is received when there are no more free connections (see the **TCP Connection Limit**), this determines what happens:

0	The least recently active connection will be dropped in favor of the new connection.
>0	The least recently active connection will be dropped in favor of the new connection, but only if the least recently active connection has been inactive for at least this many seconds.
None	The new connection will be dropped immediately after it is accepted.

4.10.5 TCP Connection Limit

The maximum number of active TCP connections that the Modbus server will maintain. Above this limit, the TCP Timeout value will be used to decide how new connections should be handled.

4.10.6 Port

The TCP/UDP port number on which to listen for new connections/requests.

4.10.7 Register Mapping

The Modbus registers (all discrete inputs) that may be polled for switch status are:

Link Status for Ports 1-16

10001	Link status of port 1 (1 = link present, 0 = no link present)
10002	Link status of port 2
...10016	Link status of port (register - 10000)

Real-Time Ring Status for Rings 1-4

10017	Ring 1: Ring is complete (1 = complete, 0 = broken)
10018	Ring 1: First port is passing data (1 = active, 0 = blocked)
10019	Ring 1: Second port is passing data (1 = active, 0 = blocked)
10020	Ring 2: Ring is complete
10021	Ring 2: First port is passing data
10022	Ring 2: Second port is passing data
10023	Ring 3: Ring is complete
10024	Ring 3: First port is passing data
10025	Ring 3: Second port is passing data
10026	Ring 4: Ring is complete
10027	Ring 4: First port is passing data
10028	Ring 4: Second port is passing data

Switch Status

10030	OK output (1 = on/no alarm, 0 = off/alarm)
10031	First power input active (1 = P1 on, 0 = P1 off)
10032	Second power input active (1 = P2 on, 0 = P2 off)

Extended Link Status for Ports 1-99

10101 Link status of port 1 (1 = link present, 0 = no link present)

10102 Link status of port 2

...10199 Link status of port (register - 10100)

Extended Ring Status for Rings 1-25

10200 Ring 1: Ring is complete (1 = complete, 0 = broken)

10201 Ring 1: First port is passing data (1 = active, 0 = blocked)

10202 Ring 1: Second port is passing data (1 = active, 0 = blocked)

10203 Ring 1: Reserved (always 0)

...10299

Ring X status (X = ?(register - 10200) ÷ 4? + 1)

10200 + (X - 1) × 4 + 0 Ring X: Ring is complete

10200 + (X - 1) × 4 + 1 Ring X: First port is passing data

10200 + (X - 1) × 4 + 2 Ring X: Second port is passing data

10200 + (X - 1) × 4 + 3 Ring X: Reserved (always 0)

Extended Switch Status

10300 OK output (1 = on/no alarm, 0 = off/alarm)

10301 First power input active (1 = P1 on, 0 = P1 off)

10302 Second power input active (1 = P2 on, 0 = P2 off)

MODBUS

Help

Configure the Modbus server. This server allows for the use of the Modbus protocol to poll select status values from the switch. Such values include port link status, power status, and Real-Time Ring status.

MODBUS CONFIGURATION

Enabled	☑
Station Number	1
Transport Layers	tcp+udp
TCP Timeout	0 ☐ None
TCP Connection Limit	4
Port	502

Commit Changes

Chapter 5 Network Management (SNMP and RMON)

5.1 SNMP, MIB and RMON Groups

SNMP (Simple Network Management Protocol) and RMON (Remote Monitoring) provide a means to monitor and manage your network. Each SNMP device maintains Management Information Bases (MIBs) containing information about the operation and configuration of the device.

Note: This product uses Net-SNMP (available from www.net-snmp.org) which is subject to the copyrights and license found at: http://www.net-snmp.org/COPYING.txt

The MIBs can be accessed with SNMP tools ranging from simple command-line tools like snmpwalk and snmpget (part of the open source Net-SNMP package available at http://www.net-snmp.org) to commercial network management products from various vendors. Key information from the MIBs is also available via the switch's terminal and web interfaces.

The MIBs are divided into groups of related objects. Objects may be scalar (having only a single value) or tabular (having a list of values varying over time, by port number, etc.).

For a list of the supported MIB and RMON groups, see Appendix D SNMP Support on page 146.

5.2 SNMP Security

SNMP provides several options for securing access to MIBs. SNMPv1 and SNMPv2 provide only weak authentication. SNMPv3 uses encryption to add stronger authentication as well as privacy. In all versions, you may configure read-only and read/write users.

SNMPv1 and SNMPv2 authenticate users with a “community string” which is sent in clear text (unencrypted) and no password is required. Some measure of security can be achieved by setting long, obscure community strings.

SNMPv3 provides three levels of security and encryption:

- None–No password is required to read or write values in the MIB.

- **Authentication**–A password is required and is used to encrypt the user credentials so that security information is not sent in clear text. A variation of MD5 is used for encryption.
- **Privacy**–A password is required and is used to encrypt the user credentials. A second password is used to encrypt the details of the SNMP request using DES encryption.

For SNMPv3 access, the managed switch requires authentication and allows privacy. Only one password is configurable and it is used for both authentication and privacy.

The following examples use snmpget from the Net-SNMP tools to illustrate the use of authentication and privacy when accessing the managed switch.

If SNMPv2 access is enabled, values may be read without a password with a command like:

```
snmpget -v 2c -c public 10.2.0.1 system.sysDescr.0
```

If SNMPv3 access is enabled, values may be read with a command like the following (entered all on one line):

```
snmpget -v 3 -u public -l authNopriv -a MD5
-A publicpwd 10.2.0.1 system.sysDescr.0
```

Finally, if SNMPv3 access is enabled, an authenticated, private request could be made with a command like the following:

```
snmpget -v 3 -u public -l authpriv -a MD5 -A publicpwd
-x DES -X publicpwd 10.2.0.1 system.sysDescr.0
```

The switch supports SNMPv1, v2, and v3. SNMPv1 and v2 access are essentially the same from a security standpoint and are enabled and disabled together. SNMPv3 security may be separately controlled. Thus you may prevent unauthenticated access to your switch by disabling SNMPv1/v2 access entirely while retaining password-secured access via SNMPv3.

5.3 SNMP Notifications

Use the SNMP Notifications Menu to enable traps to be sent when the state of the switch changes. Access this menu by selecting Setup from the Main Menu, and then selecting Main Settings.

Use the SNMP Notifications Menu to enable traps to be sent when the state of the switch changes. Access this menu by selecting **Setup** from the **Main Menu**, and then selecting **Main Settings**.

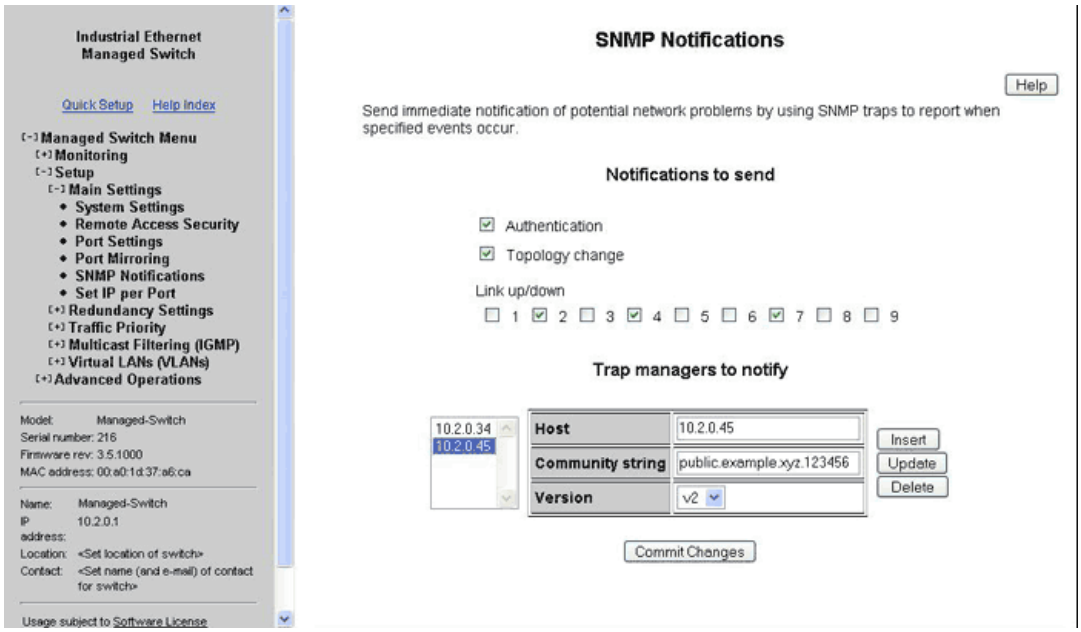
- **Authentication**– Traps can be sent when invalid credentials (such as an unrecognized community string) are presented to the SNMP agent. Enable this setting to generate authentication traps.
- **Topology change**– Traps can be sent when the topology of the spanning tree changes. Enable this setting to generate topology change traps.
- **Link 1 up/down-Link 18 up/down**– Traps can be sent when a link goes up or down (the same state reflected in the LED for each port). Enable these settings to generate link up/down traps.

5.4 Trap Managers

Use the **Trap Managers Menu** to specify where traps will be sent. The **Trap Managers Menu** can be accessed by selecting **Setup** from the **Main Menu** and then selecting **Main Settings**. Up to five trap managers may be configured. For each one, the following values may be specified.

- **Host**–The IP address of the host where the trap manager is located.
- **Community String**–The community string to use when contacting the trap manager on the host.
- **Version**–The SNMP trap version to send.

Note: There are two system traps that cannot be disabled and will be sent to any configured trap managers. A coldStart trap will be sent whenever the SNMP agent starts up (usually, this is only when the switch is reset). A NotifyRestart trap will be sent whenever the SNMP agent's configuration changes and is reloaded. This will happen, for example, when you commit changes on a configuration menu that includes SNMP settings.

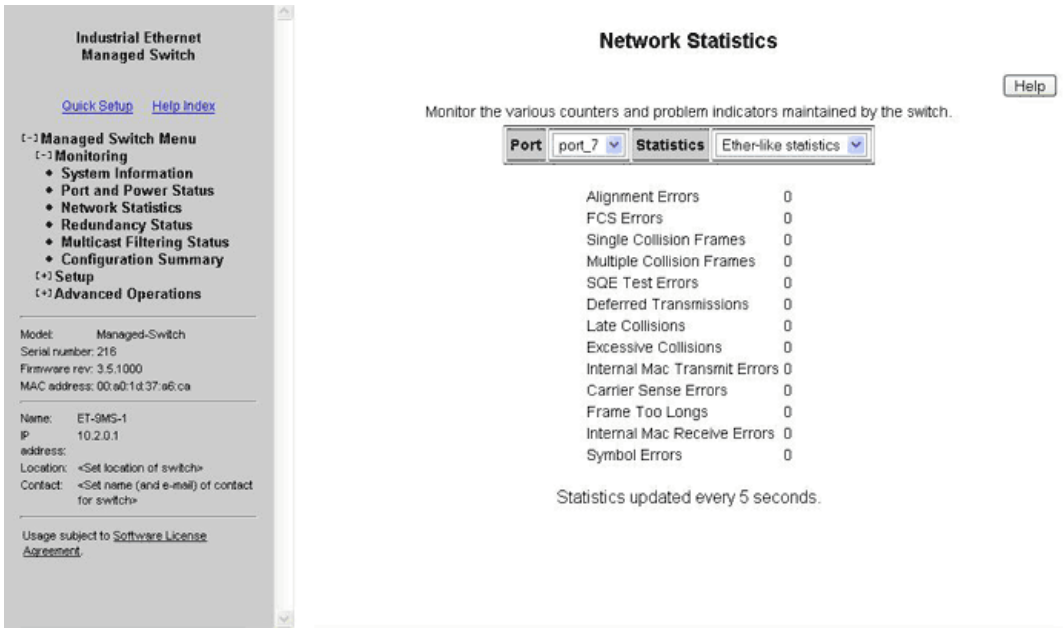


5.5 Network Statistics

The Network Statistics page shows a subset of the performance data from SNMP and RMON. Select RMON (Remote Monitoring) statistics or Ether-like statistics and the desired port number. The display will be updated every 5 seconds.

5.5.1 Ether-Like Statistics

Selecting Ether-like statistics will display various Ethernet statistics for the selected port, for which can be used to determine how your network is performing. These statistics come from the Dot3 MIB (RFC 2665).



The following statistics are provided:

- **Alignment Errors**– Happens when the Ethernet Interface cannot synchronize with the incoming packet because it is not of expected length (packet received has invalid CRC).

  Causes: This is possibly caused by interference and attenuation. Check for faulty wiring, NICs, or possible causes of interference/line noise.

- **FCS Errors**–This error happens when packets have a bad Frame Check Sequence.

- **Single Collision Frames**–This happens when an Ethernet device tries to send a frame but discovers that there is at least one other device on the network trying to send at the same time (collision detected). When a collision is detected the network devices prepare to access the network medium again, but only after waiting for a random amount of time. Collisions are common in an Ethernet network and collision detection allows the devices on an Ethernet network to work. When the Ethernet device tries to transmit that same frame again and is successful, it is called a single collision.

- **Multiple Collision Frames**–Multiple collisions happen when the Ethernet device tries to transmit a frame through the network medium, but detects a collision. The Ethernet device tries again to transmit the same frame through the network but again encounters another collision. The error count is incremented each time a particular frame fails after the first attempt of transmission.

- **SQE Test Errors**–A network device checks for the Signal Quality Error Transmission to see if the collision detection circuitry is working. For whatever reason that the network device does not detect the SQE transmission, the SQE test error counter is incremented.

- **Deferred Transmissions**–A transmission is deferred when a device is attempting to access the network but another device is already transmitting (by detecting a carrier signal, not a collision) on the network.

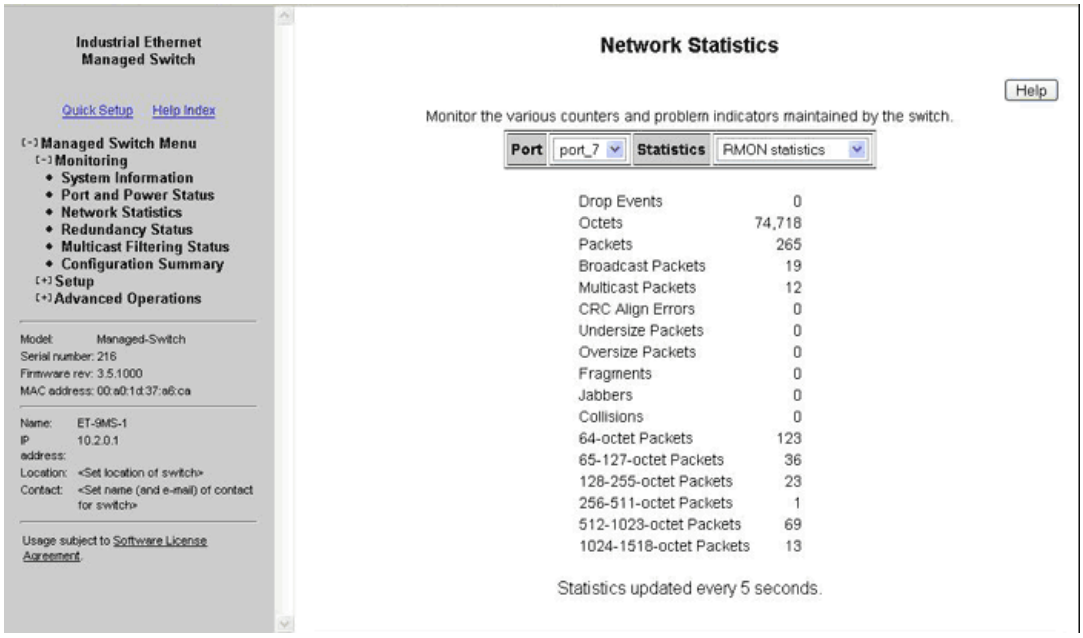
- **Late Collisions**–When an Ethernet Device starts transmitting a frame on the network medium, it believes that it can transmit because it didn't detect a collision. If for some reason the Ethernet device is transmitting, but after a given time period during the frame transfer it realizes

that it really wasn't clear to transmit because it detected a collision; that is called a late collision. For a 10BASE-T network, a collision is detected (by the device that is transmitting that frame) after 51.2 microseconds into a frame transfer is considered a late collision. For a 100BASE-T network, a collision is detected (by the device that is transmitting that frame) after 5.12 microseconds into a frame transfer is considered a late collision.

Causes: Late collisions usually come from a problem on the network such as improper configuration, compliance issues between network devices, incorrect cabling, and faulty Network Interface Cards.

- **Excessive Collisions**–When an Ethernet Device attempts to transmit a frame but detects a collision, it attempts to retry to send the same frame at another random time. Should the Ethernet device fail to transmit that particular frame after 16 tries, the Ethernet device gives up and the frame will not be transmitted.
- **Internal MAC Transmit Errors**–When frames fail to be transmitted correctly due to an internal MAC sub-layer transmit error.
- **Carrier Sense Errors**–When an Ethernet device loses the carrier sense condition whenever a frame is being transmitted. The error is incremented a maximum of one time per transmission attempt (no matter how many times the carrier sense condition fluctuates during a single transmission attempt).
- **Frame Too Longs**–Every time there is a frame that is encountered to exceed the maximum frame size.
- **Internal MAC Receive Errors**–When frames fail to be received correctly due to an internal MAC sub-layer receive error.
- **Symbol Errors**–This happens when the system could not correctly decode a symbol that it has received. Selecting RMON Statistics will display Remote Monitoring statistics for the selected port that can be used to determine how your network is performing. These statistics come from the RMON MIB (RFC 1757).

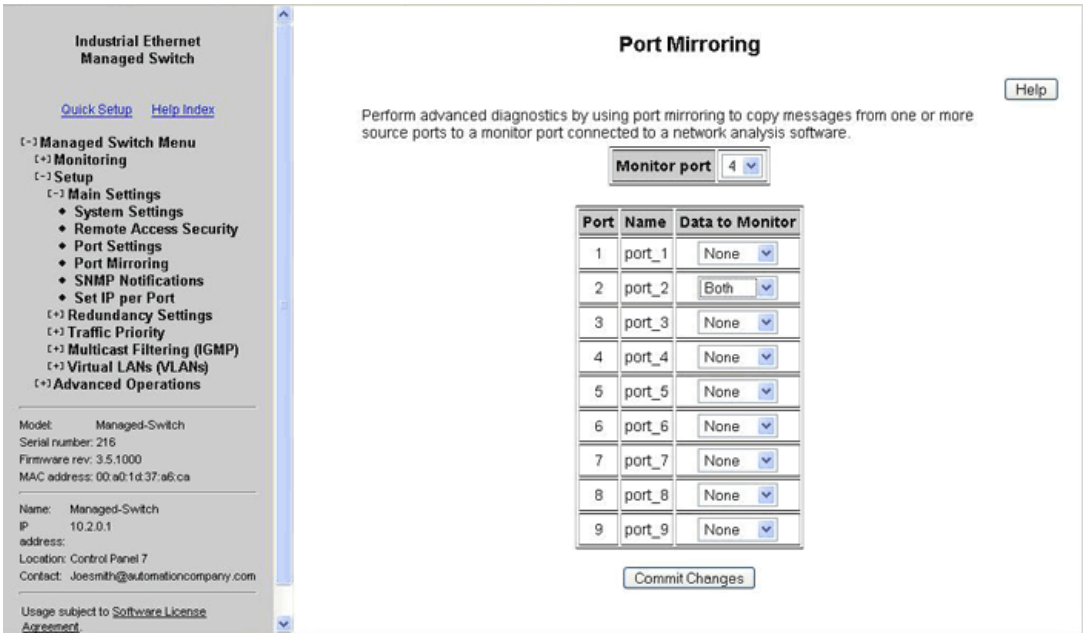
5.5.2 RMON Statistics



- **Drop Events**: A packet has been dropped due to insufficient switch resources.
- **Octets**: # of data octets received.
- **Packets**: # of packets received.
- **Broadcast Packets**: # of broadcast packets received.
- **Multicast Packets**: # of multicast packets received.
- **CRC Align Errors**: # of packets received with an invalid CRC.
- **Undersize Packets**: # of packets received less than 64 bytes with a valid CRC.
- **Oversize Packets**: # of packets received more than 1536 bytes with valid CRC.
- **Fragments**: # of packets received that are less than 64 bytes.
- **Jabbers**: # of packets received more than 1536 bytes with invalid CRC.
- **Collisions**: # of collisions detected.
- **64-octet Packets**: # of packet of size 64 bytes received.
- **65-127-octet Packets**: # of packets of 65 to 127 bytes received.
- **128-255-octet Packets**: # of packets of 128 to 255 bytes received.
- **256-511-octet Packets**: # of packets of 256 to 511 bytes received.
- **512-1023-octet Packets**: # of packets of 512 to 1023 bytes received.
- **1024-1518-octet Packets**: # of packets of 1024-1518 bytes received.

5.6 Port Mirroring

The mirroring option is ideal for performing diagnostics by allowing traffic that is being sent to and received from one or more source ports to be replicated out a monitoring/target port. The Port Mirroring menu is accessed by selecting Setup from the Main menu, and then selecting Main Settings.



When enabling the port-mirroring feature, choose the source ports to be mirrored (monitored) and the "sink" port to monitor their traffic. For each source port, choose to monitor messages being sent (select Egress), messages being received (select Ingress) or messages being sent and received (select Both).

In the sample image above, port 4 is monitoring messages from port 2.

5.7 Alarm (OK) Output

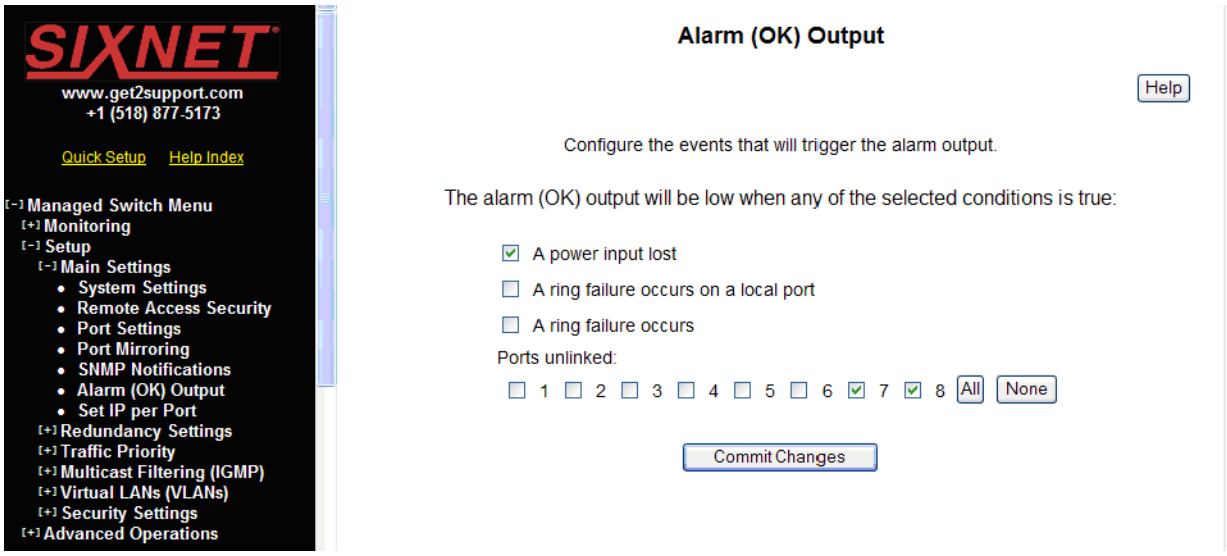
The OK output can be configured to report a number of conditions by setting the Alarm output. This a discrete output which will be high during normal conditions and low when an alarm is triggered. To force the OK output to be always on, simply disable all alarm options.

- **Power Input Lost**: In switches with redundant power inputs, an alarm condition will be triggered when power is not supplied to one of the inputs. This is the only alarm enabled by default.
- **Ring Failure**: An alarm condition will be triggered when a ring failure occurs.

  Ring failure on a local port will be triggered when one of this switch's neighbors in the ring goes down; the general ring failure option will be triggered when any switch in the ring goes down.

  The general ring failure option implies that local ring port failure is also detected.
- **No Carrier Detected (-MDM models only)**: An alarm condition will be triggered when there is no carrier signal detected on the phone line (i.e., when the modem achieves carrier detect, the OK output will be high).

- **Ports Unlinked**: Alarms can be configured for one or more ports, so that the OK output will be low when one of the selected ports is unlinked.



Chapter 6 Redundancy Protocols

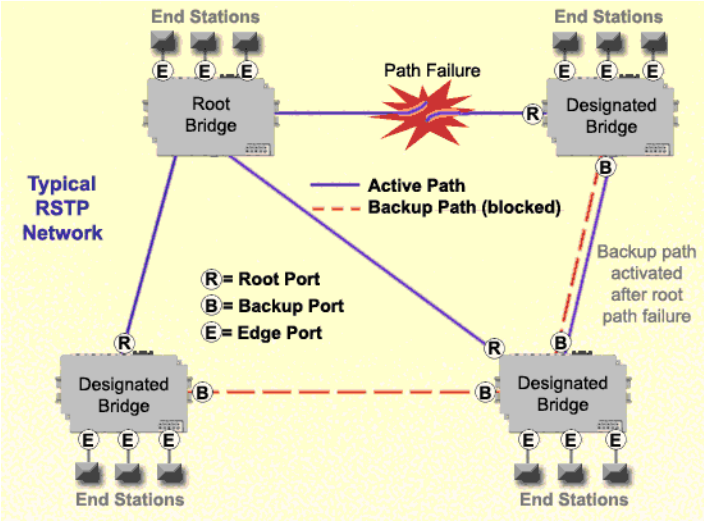
6.1 What Is RSTP?

The Rapid Spanning Tree Protocol (RSTP) allows you to have an Ethernet network with extra connections, so if one path between two points on the network fails, another path can be used to deliver messages. If one link or switch fails, another link or switch can take over transparently to prevent unnecessary down time. So why not just physically connect each of the switches in your network in various loop configurations such that there are always at least two paths going to and from each switch? A good idea, but it creates broadcast loops that will bring a network to its knees very quickly.

In an unmanaged Ethernet network there can be only one path between any two ports on the network. If there is more than one path from one switch to another a broadcast message (and in some cases other messages) sent by the network will be forwarded until it completes a loop by returning on the second path. Since the switches forward all broadcasts and do not keep track of the messages they have sent, the returning message will be sent around the loop again and again. A single message circulating forever around a loop at high speed is clearly not a good thing, so no loops are allowed.

The limitations of having only one path are even simpler to see. If the one and only path fails for any reason, such as a broken cable or power failure at one of the switches, there are no paths left and no network traffic can get through. We need a way to add alternate paths without creating loops. Thus the use of Rapid Spanning Tree Protocol, a loop prevention protocol, is used such that switches can communicate with each other to discover and prevent loops.

In this diagram, the root ports are those connected directly to the root bridge because they have the lowest port cost (only one hop). The paths that must go through another bridge (switch) have a higher port cost (two hops) and are designated as backup ports. The ports connected directly to end stations are assigned as edge ports so that RSTP doesn't waste time considering them.



The Rapid Spanning Tree Protocol provides a standardized means for intelligent switches (also called bridges) to enable or disable network paths so there are no loops, but there is an alternative path if it is possible. Why is it called Rapid Spanning Tree Protocol?

- 'Rapid'–it is faster than the previous (and completely compatible) version called Spanning Tree Protocol (STP).
- 'Spanning'– it spans (connects) all of the stations and switches of the network.
- 'Tree'–its branches provide only one connection between two points.

In a Spanning Tree network, only one bridge (managed switch) is responsible for forwarding packets between two adjacent LAN segments to ensure that no loops exist in a LAN. To ensure that only one bridge is responsible, all other bridges on the network must cooperate with each other to form a logical spanning tree that defines the pathways that packets should take from bridge to bridge.

The logical spanning tree has exactly one bridge that is assigned the role of root. All of the other bridges need to have exactly one active path to the root. The job of the root bridge is to notify all bridges connected in the tree that there has been a topology change and restructuring of the tree is in progress (due to a communications link failure somewhere in the network). The root bridge is determined by the bridge priority assigned to it and the MAC address.

By default, it is the bridge with the lowest MAC address that gets assigned the role as "root", but a specific bridge can be forced to be the root bridge by changing its bridge priority setting (a lower number with respect to other bridges means higher priority).

Every communication path between each bridge (managed switch) on the network has an associated cost. This "path cost" may be determined by the speed of each segment, because it costs more time to move data at a slower speed. The path cost can be configured to encourage or discourage the use of particular network. For example, you may not want to use a particular high-speed link except when absolutely necessary because there is a charge (money) for data using that path, while another path is free (no monetary cost).

The root path cost is the cumulative cost of all the network paths from the root bridge to a particular port on the network. A Spanning Tree network always uses the lowest cost path available between a port and the root bridge. When the available network connections change, it reconfigures itself as necessary.

See the RSTP Examples topic in this section for an example of how the path cost can be utilized to establish the primary and backup connections.

During the start-up of a Spanning Tree Network, all bridges (managed switches) are transmitting configuration messages (BPDUs) claiming to be the root. If a switch receives a BPDU that is “better” than the one it is sending, it will immediately stop claiming itself as the root and send the “better” root information instead. Assuming the working network segments actually connect all of the switches, after a certain period of time there will be only one switch that is sending its own root information and this bridge is the root. All other switches transmit the root bridge's information at the rate of the root bridge's “hello time” or when the root bridge's BPDU is received on one of their ports.

The only factor for determining which switch is the root (has the “best” root information) is the bridge priority and its tie-breaker, the switch MAC address. If a switch has more than one path to get messages from the root, other information in the configuration message determines which path is the best.

Once the root bridge is determined, all other switches see the root bridge's information and information about path (or paths) to the root. If more than one port provides a path to the root the non-root switches must decide which port to use. They check all of their ports to select the port that is receiving messages indicating the best path to the root.

The selected port for each bridge is called the root port. It provides the best path to communicate with the root. The best path is determined first by the lowest total path cost to the root (root path cost). Each port is assigned a cost (usually based on the speed) for messages received on that port. The root path cost for a given path is just sum of the individual port costs for that path. The lowest path cost indicates the shortest, fastest path to the root. If more than one path has the same cost the port priority assigned to each port, and its tie-breaker the port number pick the best path.

6.2 Recovery Time, Hops and Convergence

The typical RSTP recovery time (time to start forwarding messages on the backup port) on a link-loss failure is <50 mS per “hop” (firmware version 3.1 or higher). A hop is defined as a link between two switches. A link to an end station is not considered a hop.

The Max Age setting controls how long RSTP messages may circulate in the network. Since the largest value allowed for Max Age is 40, the largest RSTP network hop-diameter is also 40.

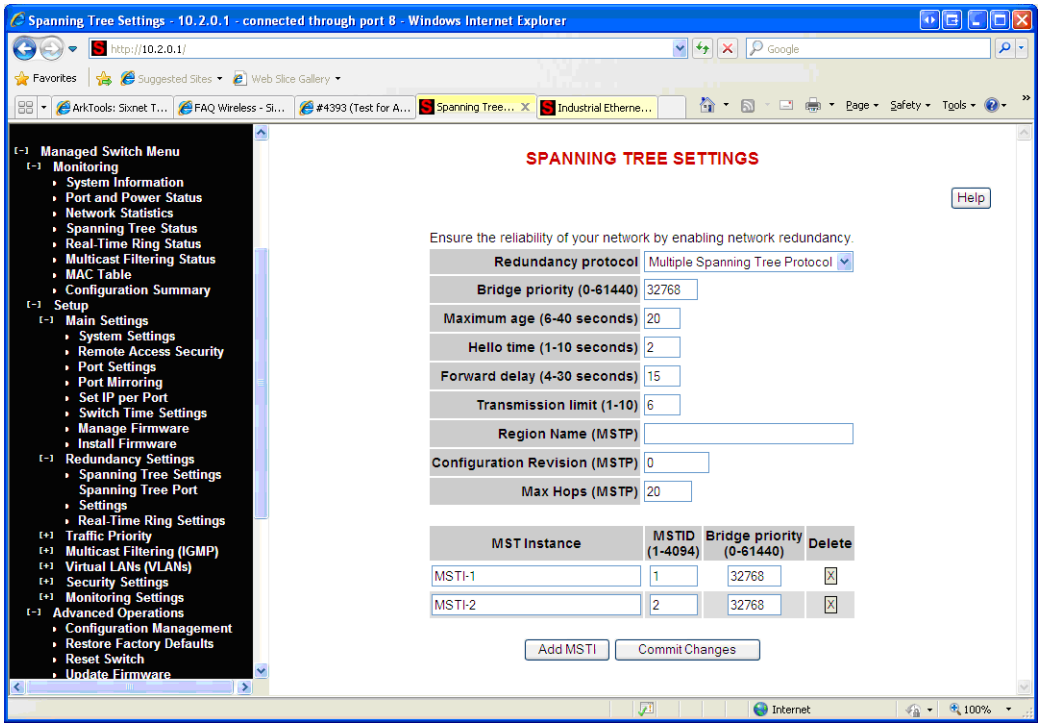
See the RSTP Examples topic in this section for a more detailed explanation about hops and recovery time.

The time it takes for all of the switches to have a stable configuration and send network traffic is called the convergence time. STP was developed when it was acceptable to have a convergence time of maybe a minute or more, but that is not the case anymore. Due to the increased demand for better convergence times, Rapid Spanning Tree Protocol was developed, bringing the normal convergence time for a properly configured network down to a few seconds. The RSTP takes advantage of the fact that most modern Ethernet links between switches are point-to-point connections. With a point-to-point link, the switches can quickly decide if the link should be active or not.

6.3 Spanning Tree Settings

The Spanning Tree Settings enable you to choose the redundancy protocol and set parameters related to that protocol.

To access the Spanning Tree Settings, choose Managed Switch Menu>Main Settings>Setup>Redundancy Settings>Spanning Tree Settings.



6.3.1 Redundancy Protocol (Default = Rapid Spanning Tree Protocol)

Choose the protocol by selecting STP (Spanning Tree Protocol), RSTP (Rapid Spanning Tree Protocol) or MSTP (Multiple Spanning Tree Protocol). A selection of None will disable this advanced feature. Choosing STP, RSTP or MSTP will allow the wiring of redundant networks (such as rings) for automatic failover. RSTP is compatible with STP so in most cases you can just choose RSTP. Only choose STP if you want to force the switch to only use this protocol. STP/RSTP/MSTP use BPDUs (Bridge Protocol Data Units) to keep bridges informed of the network status.

MSTP is compatible with RSTP and STP but adds the ability to route VLANs over distinct spanning trees within an MSTP region. In order to configure the spanning trees, you must create spanning tree instances using the STP configuration page and assign VLANs to them using the VLAN configuration page.

MSTP falls back to RSTP behavior outside of an MSTP Region. A region is identified by the unique combination of Region Name, Configuration Revision and VLAN to MSTI mapping for each switch in that region. If those values match for linked switches running MSTP, those switches consider themselves to be in the same region.

Caution: If VLANs and redundancy (STP/RSTP/MSTP) are both enabled, situations can arise where the physical LAN is intact but one or more VLANs are being blocked by the redun-

dancy algorithm and communication over those VLANs fails. The best practice is to make all switch-to-switch connections members of all VLANs to ensure connectivity at all times.

Select none if you do not require the switch to manage redundant network connections. All ports will forward network traffic just as an unmanaged switch would. Otherwise RSTP (Rapid Spanning Tree Protocol) should usually be selected. A selection of STP or RSTP will allow redundant links between switches so those links can keep the network connected even when a primary link fails. RSTP is compatible with switches that only implement plain STP, an older version of the protocol. If STP is selected only the original STP format messages will be generated. Selecting STP reduces the chances of network packets being duplicated or delivered out of order, but at the expense of much longer reconfiguration time.

Note: Should you intend to use RSTP and VLANs at the same time, please see 9.4 VLAN with RSTP on page 81 for important information concerning the setup of your network. Otherwise, communication failures may occur.

6.3.2 Bridge Priority (0 to 61440; Default = 32768

The bridge priority is used to determine the root bridge in the spanning tree. (For MSTP, the bridge priority is used to determine the CIST root.) The priority ranges from 0 to 61440 (default 32768) and must be a multiple of 4096. Lower numbers indicate a better priority.

By default, the bridge with the lowest bridge priority is selected as the root. In the event of a tie, the bridge with the lowest priority and lowest MAC address is selected.

There are two ways to select a root bridge (switch). The first is to leave all the bridge priority settings at the default setting of 32768. When all the switches are set at the default priority, the managed switch with the lowest MAC address is selected as the root. This may be adequate for networks with light or evenly distributed traffic.

The second way to select a root bridge is to customize priority settings of each bridge. Customizing the bridge priority settings allows the network to select a root bridge that gives the best network performance. The goal is generally to have the network traffic pass through the network as directly as possible, so the root should be central in the network. If most messages are between one central server and several clients, the root should probably be a switch near the server so messages do not take a long path to the root and another long path back to the server.

Once you decide which switch should be the root, it should be given the best (numerically lowest) bridge priority number in the network.

6.3.3 Maximum Age (6 to 40; Default = 20)

For STP, the max age indicates the maximum time (in seconds) that the switch will wait for configuration messages from other managed switches. If that time expires, the switch assumes that it is no longer connected to the root of the network. If a link goes down in a way that the switch can detect as loss of link, it does not wait before reconfiguring the network.

RSTP waits 3 times the Hello Time instead of Max Age before assuming that it is no longer connected to the root of the network. However, Max Age is used to limit the number of hops Spanning Tree information may travel from the root bridge before being discarded as invalid. Furthermore, MSTP only counts hops that take place to or from switches outside the MSTP region for this check. The value of Max Hops (below) is used to limit hops within an MSTP region.

Note: Assign all switches in an RSTP/STP network the same max age.

The maximum age must satisfy the following constraints:

2 × (hello time + 1.0 seconds) ≤ max message age ≤ 2 × (forward delay - 1.0 seconds)

6.3.4 Hello Time (1 to 10; Default = 2)

Configuration messages (BPDUs) are either sent periodically to other bridges based on a time period labeled hello time. Decreasing the hello time gives faster recovery times; increasing the hello time interval decreases the overhead involved.

The hello time must satisfy the following constraints:

2 x (hello time + 1.0 seconds) ≤ max message age ≤ 2 x (forward delay - 1.0 seconds)

6.3.5 Forward Delay (4 to 30; Default = 15)

The forward delay is a time (in seconds) used by all switches in the network. This value is controlled by the root bridge and is used as a timeout value to allow ports to begin forwarding traffic after network topology changes. If a port is not configured as an edge port and RSTP cannot negotiate the link status a port must wait twice the forward delay before forwarding network traffic. In a properly configured network using RSTP (not STP) this setting has very little effect. For STP networks, setting the time too short may allow temporary loops when the network structure changes (switches turn on or off or links are added or broken). A longer time will prevent temporary loops, but network traffic will be disrupted for a longer time.

The default value for the forward delay is 15 seconds. If you change this setting, the switch will not allow a value unless it satisfies the following formula:

2 × (hello time + 1.0 seconds) ≤ max message age ≤ 2 x (forward delay - 1.0 seconds)

6.3.6 Transmission Limit (1 to 10; Default = 6)

The transmission limit controls the maximum number of BPDUs that can be sent in one second.

The transmission limit can range from 1 to 10 messages/second (6 messages/second default). Increasing Transmission limit can speed convergence of the network but at the cost of configuration messages using a larger share of the available network bandwidth.

6.3.7 Region Name (MSTP)

The region name is used together with the configuration revision and VLAN to MSTI mapping to define an MSTP region.

6.3.8 Configuration Revision (MSTP; 0 to 65535)

The configuration revision is used together with the region name and VLAN to MSTI mapping to define an MSTP region.

6.3.9 Max Hops (MSTP; 6 to 40; Default = 20)

Max Hops determines the maximum number of switches a BPDU will be propogated through within an MSTP region. This value is used to prevent old data from endlessly circulating within a region.

6.3.10 MST Instances

For MSTP, you can configure multiple spanning tree instances. Add an instance by clicking Add MSTI. For each MSTI, you can configure a name, the MST ID, and this bridge's priority in that spanning tree instance.

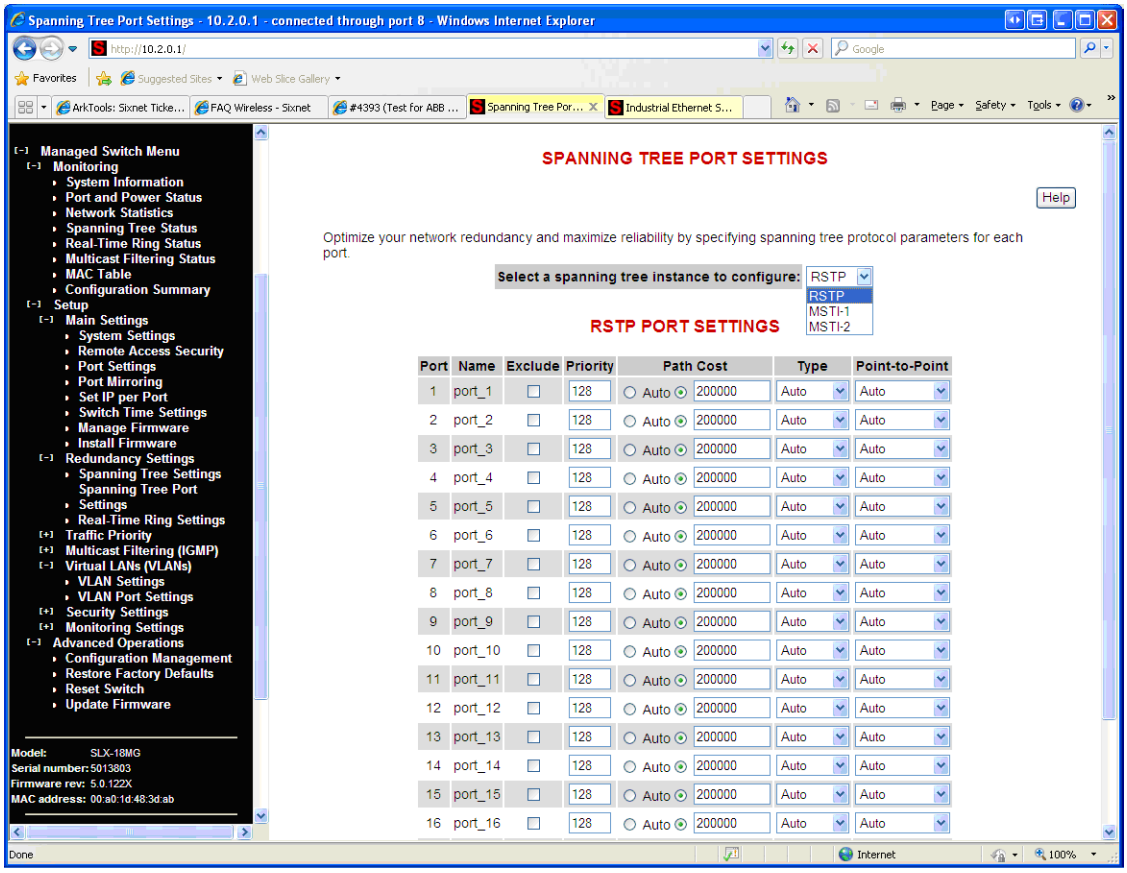
6.4 Spanning Tree Port Settings

Each port can be configured to tune the STP/RSTP/MSTP spanning tree. With MSTP, each spanning tree instance can be tuned independently.

Using MSTP, you can configure separate port settings for the CIST (Common Internal Spanning Tree) and for every spanning tree created by MSTP. Settings for individual MSTIs (Multiple Spanning Tree Instances) only affect ports connected to switches within the same MSTP Region.

By default, MSTIs inherit their settings from the CIST. To configure an MSTI individually, you must select it from the drop-down box and click the **Customize** button for the instance. Click **Inherit** if you want a spanning tree's values to be inherited from the CIST again.

To access the Spanning Tree Port settings, choose Managed Switch Menu>Main Settings>Setup> Redundancy Settings>Spanning Tree Port.



The next sections explain each of the port settings.

6.4.1 Exclude (Default = Included)

Normally all ports should be included in determining the Spanning Tree network topology, either as a normal port or an edge port. It is possible to completely exclude a port, so that it will always forward network traffic and never generate or respond to network messages for RSTP or STP. Excluding a port is an advanced option that should be used only if absolutely necessary.

This option excludes the port from all spanning tree instances and appears with the other CIST settings.

6.4.2 Port Priority (0 to 240; Default = 128)

Selection of the port to be assigned “root” if two ports are connected in a loop is based on the port with the lowest port priority. If the root bridge fails, the bridge with the next lowest priority then becomes the root.

This option may be set per port per MSTI.

If the switch has more than one port that provides a path to the root bridge and they have the same root path cost, the selection of which port to use is based on the port priority. The port with the best (numerically lowest) priority will be used. If the port priority is the same, the switch will use the lowest numbered port. The port priority can range from 0 to 240 seconds (128 second default).

6.4.3 Path Cost (1 to 200,000,000)

As with any network, there is an associated cost to go from a source location to a destination location. For RSTP, the root path cost is calculated based on the bandwidth available for that particular connection to the root bridge. The port with the lowest cost for delivering messages to the root is used to pass traffic toward the root.

The path cost can be assigned automatically based on the port speed, using the IEEE standard values of 200,000 for 100Mbps links and 2,000,000 for 10Mbps links, or the value can be specified in the range 1 to 200,000,000.

The default value depends on the capabilities of the port: 200,000 for 100 Mbps and 20,000 for 1000 Mbps ports.

This option can be set per port per MSTI.

See 6.8 RSTP Examples on page 58 for an example of how the path cost can be utilized to establish the primary and backup connections.

6.4.4 Type (Default = Auto)

A port that connects to other switches in the network may be part of a loop. To ensure such loops do not occur, the switch will not put a port in the Forwarding state until enough time has passed for the spanning tree to stabilize (twice the forwarding delay, 30 seconds by default). However, if a port connects directly to a single device at the edge of the network, it may safely be put in Forwarding state almost immediately. The port Type controls the switch's assumptions about what is connected to the port.

- Auto: The port will initially be assumed to be an Edge port and go to Forwarding quickly. It will automatically adjust to being a Network port if BPDUs are received and revert to being an Edge port any time no BPDUs are received for 3 seconds.

- **Network**: The port will always wait a safe time before going to the Forwarding state.
- **Edge**: The port will initially be assumed to be a direct connection to a single device but will change to being a Network port if any BPDUs are received. Thereafter, it will always wait a safe time before going to Forwarding whenever a link is reestablished on the port.

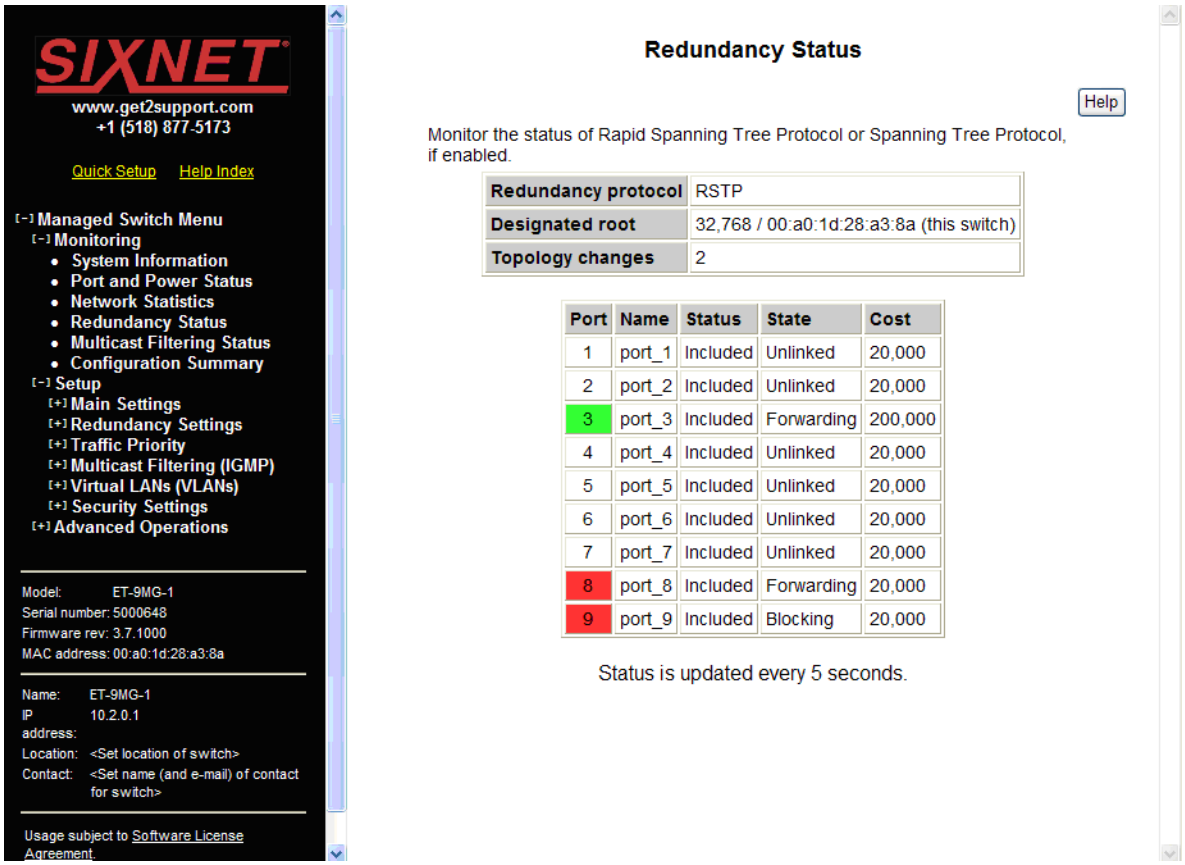
This option can be set per port per MSTI.

6.4.5 Port-to-Port MAC (Default = Auto)

A port is part of a point-to-point network segment when there can be no more than one other network port connected to it. RSTP can decide whether it is safe to forward network traffic very quickly on point-to-point links to other managed switches, otherwise the port must wait many seconds (30 seconds by default, twice the forward delay) before forwarding network traffic. When set to Auto, full-duplex links are assumed to be point-to-point, half-duplex ports are not. This setting can be forced true or false if the automatic determination would be wrong.

6.5 Redundancy Status

The Redundancy Status page, accessed through the Monitoring Menu from the Main Menu, provides a snapshot of the switch and its role in the managed network. At the top of the page, the protocol in use is displayed along with the MAC address of the current root of the spanning tree. The topology change counter will track the number of changes to the network layout. Also, the current redundancy status of each port on the switch is displayed.



- **Port**: The number of the port. This corresponds to the labels on the switch.
- **Name**: The user-configured name of the port.
- **Status**: The configured state of the port in the STP protocol (included or excluded). An included port is part of the managed network and may carry traffic to other managed switches for other devices. An excluded port will not be used as part of the managed network. For example, a single uplink from a managed network of factory devices to a business network would be configured to be excluded from STP use.
- **State**: The STP/RSTP state of the port (see below).
- **Cost**: The cost of using this port to reach other parts of the managed network.
- **STP/RSTP Port States**: In Spanning Tree Protocol, there are five port states. Rapid Spanning Tree Protocol uses just three. Table 1-1 and Table 1-2 show port states, port participation in the active Spanning Tree Topology, and port participation in learning MAC addresses for STP and RSTP respectively. All ports that are not physically connected to an Ethernet device or have a faulty connection will be labeled as “unlinked” in the port state section.

6.6 Port States for the STP Algorithm

- **Blocking (STP)**: A port in this state does not participate in frame relay (pass frames received to other locations). Once a port is in this state, it is prevented from the possibility of frame duplication caused by multiple paths in an active topology.
- **Listening (STP)**: A port in this state is about to participate in frame relay, but is not involved in any relay of frames (no frames will be forwarded). The reason for not entering frame relay immediately is to ensure that there are no temporary loops introduced when the network topology is changing. During this state, the bridge will disable all learning states on its ports to prevent the race conditions when ports are changing roles and the forwarding process will discard all frames and not submit any frames for transmission. Meanwhile BPDUs can still be received and forwarded to keep the algorithm running.
- **Learning (STP)**: A port in this state is about to participate in frame relay, but it is not involved in any relay of frames. Frame relays are not performed to prevent the creation of temporary loops during the active topology of a changing bridged LAN. In addition, the forwarding process will discard all frames and not submit any frames for transmission. The reason for enabling learning is to acquire information prior to any frame relay activities. Information gathered will be used and placed in the filtering database (MAC table) to reduce the number of frames being unnecessarily reduced.
- **Forwarding (STP)**: A port in the forwarding state is currently participating in frame relay. BPDUs will include the forwarding port in the computation of the active topology. BPDUs received are processed according to the Spanning Tree algorithm and transmitted based on the hello time or BPDU information received.

Table 6-1 801.1D STP Port States

Port States	Port Participates in Active Topology	Port Participates in Learning MAC Addresses
Disabled	No	No
Blocking	No	No
Listening	Yes	No
Learning	Yes	Yes
Forwarding	Yes	Yes

6.7 Port States for the RSTP Algorithm

To optimize the efficiency of 802.1D spanning tree protocol, certain states were condensed or eliminated to produce faster convergence times. Specifically, the disabled, blocking, and listening states in STP have been reduced down to a single discarding state in RSTP.

- **Discarding State (RSTP)**: In this state, station location information is not added to the Filtering Database (MAC table) because any changes in port role will make the Filtering Database information inaccurate.
- **Learning State (RSTP)**: In this state, information is being added to the Filtering Database under the assumption that the port role is not changing. Gathering information before frame relay (forwarding state) will reduce the number of frames sent out when entering the forwarding state.
- **Forwarding State (RSTP)**: Frames will be forwarded to and from the particular port that is in the forwarding state. In addition, during the forwarding state, the learning process is still incorporating station information into the filtering database.

Table 6-2 802.1D RSTP Port States

Port States	Ports Participating in Active Topology	Ports Participating in Learning MAC Addresses
Discarding	No	No
Learning	No	No
Forwarding	Yes	Yes

6.8 RSTP Examples

6.8.1 Example 1: Maximum “Hops” and Switches in a Redundant Ring

The Max Age setting controls how long RSTP messages may circulate in the network. When a switch receives a message, it compares the age of the message with the Max Age (also carried in the message) and if the age has reached the Max Age, the message is discarded. Otherwise, the message age is incre-

mented before the message is forwarded. Therefore, the maximum diameter of a RSTP network is controlled by Max Age. Since the largest value allowed for Max Age is 40, the largest RSTP network hop-diameter is also 40.

6.8.1.1 Number of Hops vs. Recovery Time

The diagram below shows a typical redundant ring network with 6 managed switches and 5 hops between stations.

The overall recovery time when there is a network segment failure is dependent on the number of hops. The recovery time is typically less than 50 mS per hop. Therefore, in the diagram below of a typical ring with 6 managed switches the overall recovery time would be less than 250 mS (5 hops x <50 mS).

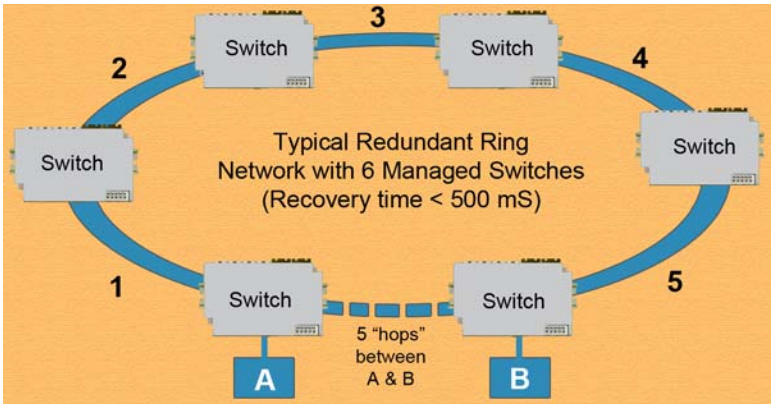
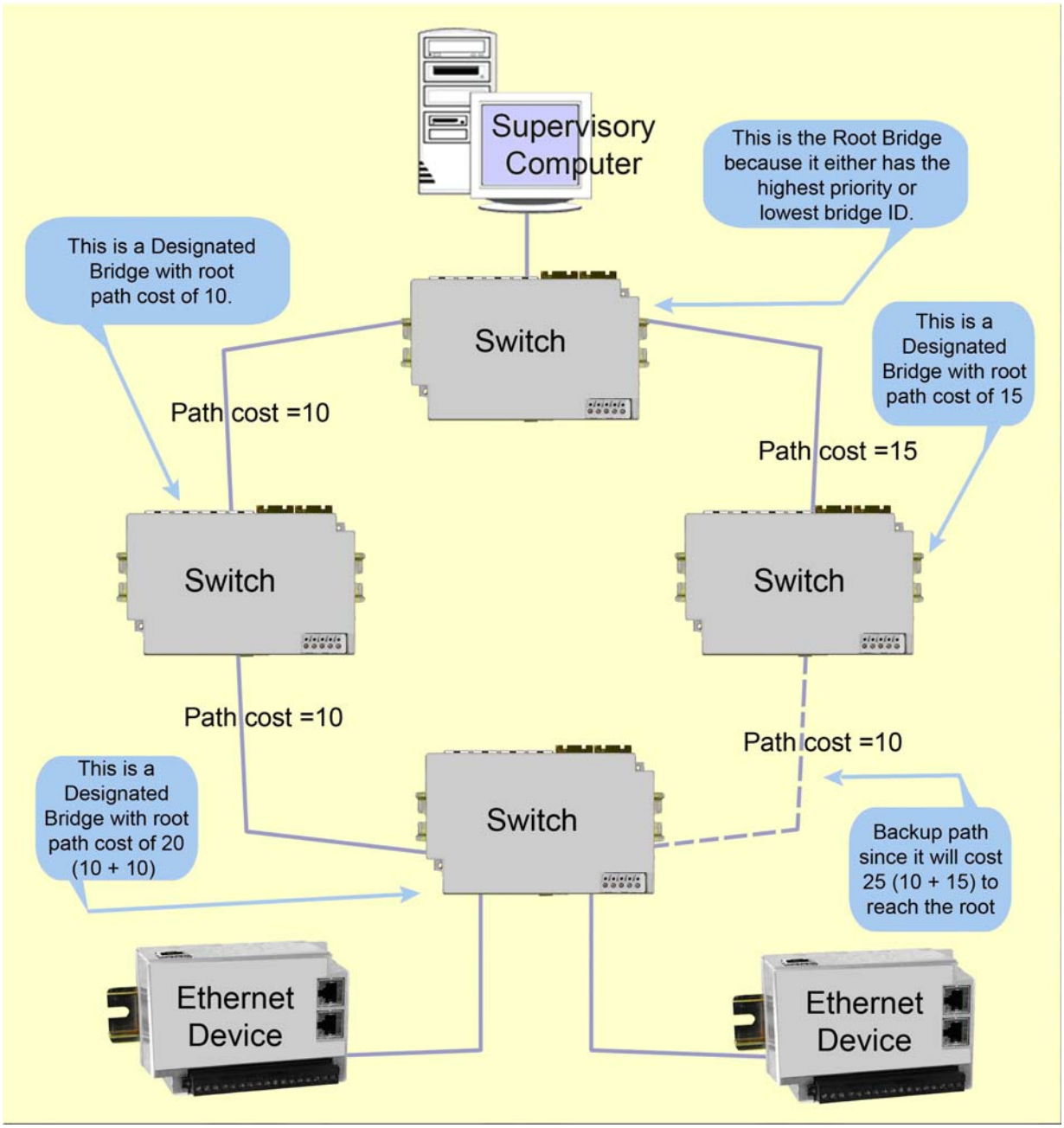


Figure 6-1 Typical Redundant Ring with Five Hops Between A and B

6.8.2 Example 2: Using Path Costs to Establish Primary & Backup Connections

The path cost can be used to distinguish the best connections to use. You can assign a higher cost to pathways that are more expensive, slower or less desirable in any way. The managed switches will then add up the path costs to determine the best route back to the root switch. See the example below.

Note: In most networks you may leave the path costs set to the default settings and allow the switches to automatically determine the best paths.

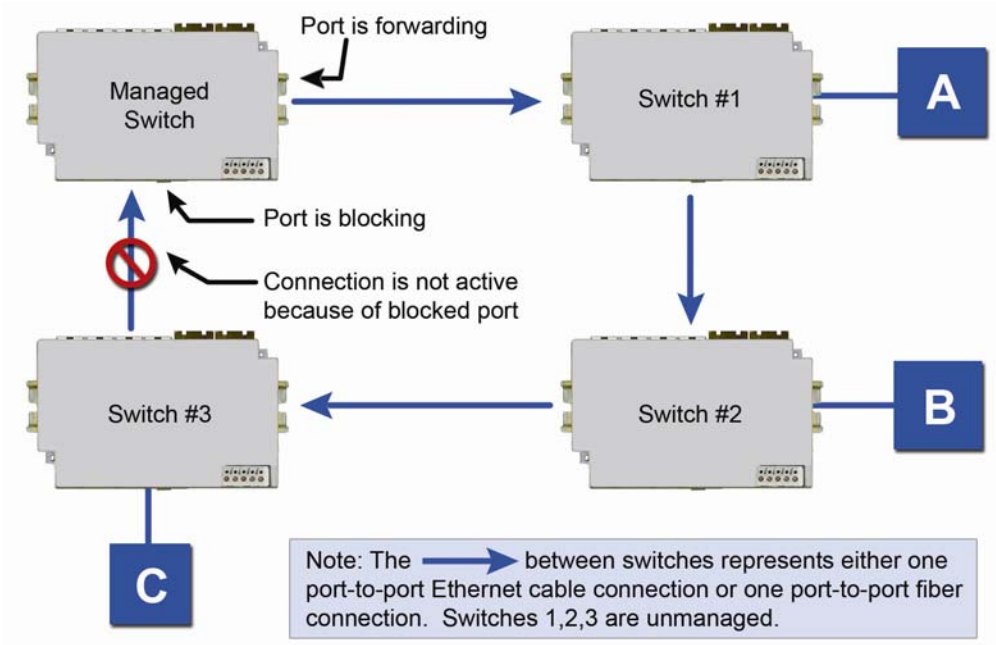


6.8.3 Example 3: Ring Topology with only one Managed Switch (Do not do this!)

Implementing a ring topology with a single managed switch and several unmanaged switches is a common question because of the thought of saving money. The topology is legal *only* if that single managed switch is a member of each ring. Although it is legal, it is *not* recommended, as the hypothetical scenario indicated below will explain why.

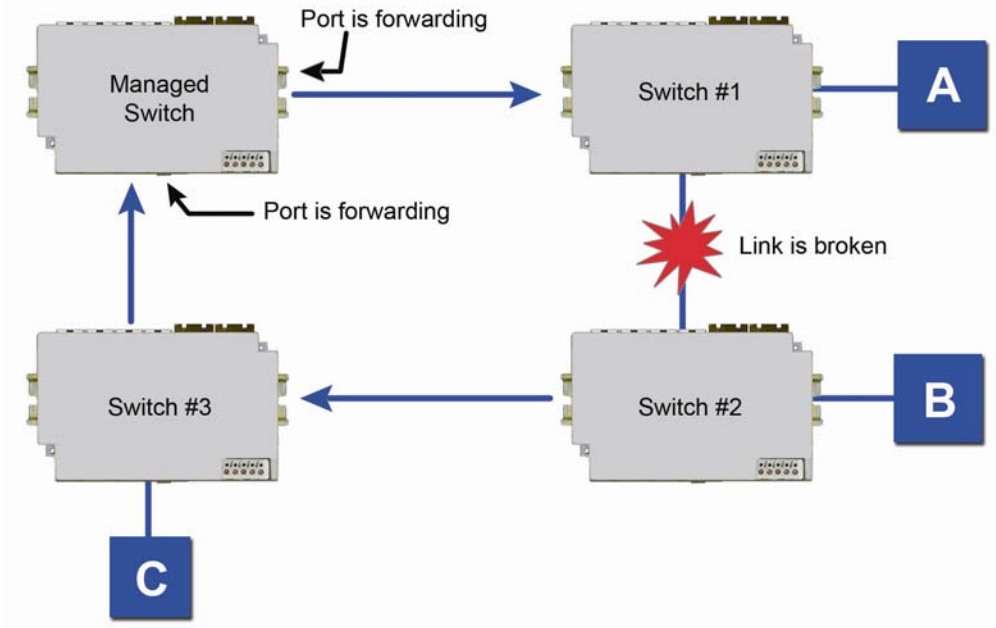
6.8.3.1 Hypothetical Scenario

An integrator wishes to use implement a single Ethernet ring topology for the proposed network. Only one managed switch is used to connect to three or more unmanaged switches in the loop (Figure 1).



Initially, everything is working fine in the network. The managed switch detects the loop by seeing its own configuration messages and based on STP parameters, chooses one port to be in the forwarding state, and the other port to be in the blocking state. No loop is formed and device A can talk to device B.

Somewhere in the plant, a construction vehicle accidentally cuts the connection between unmanaged switch #1 and unmanaged switch #2. The managed switch in the network notices (typically around 6 seconds when connected to an unmanaged switch) that the port in blocking mode is not receiving configuration messages and transitions through the listening, learning, and forwarding states (Figure 2).



This would seem to have solved the problem as both ports in the managed switch are in forwarding mode, but it is not the case. Due to the fact that the other three switches are unmanaged, they do not have the intelligence to know that there has been a change in the network topology. Switch #1 still points to switch #2 when device A is trying to talk to device B (for which it cannot, due to the broken

Ethernet link). The bottleneck has been discovered, as we have to wait until the MAC table in switch #1 ages out its entries of device A and device B. The same applies for devices connected to switch #2 (B talking to A) and switch #3 (C talking to A).

As a result of this “money saving” configuration, the network redundancy performance is traded off and left at the mercy of the time it takes to age out MAC table entries in switches 1, 2, and 3. Depending on the model of unmanaged Ethernet switch, entries in the MAC table are usually aged out in a time period of 5 minutes or more.

This introduces at least 5 minutes of downtime for the plant, which could have a very detrimental cost with respect to the operation of the plant. By replacing switches 1, 2, and 3 with managed switches, the network convergence time is brought down to a less than a second. An additional benefit is that the network is not limited to only one redundant loop and can have a “mesh” of connections for a truly redundant network scheme at all points in the network.

6.9 Real-Time Ring Settings

The **Real-Time Ring Settings** page, accessed through the **Redundancy Settings**, allows configuration of Sixnet's Real-Time Ring protocol in supported switches.

A real-time ring increases network reliability by providing an alternative path for message flow in the event of a network segment failure. When a ring port detects a communications break, it quickly notifies the other switches in the ring. Messages are automatically rerouted through the alternative ring path within milliseconds.

STP (Spanning Tree Protocol) is more flexible than a ring configuration, but recovery times for spanning trees may be in the hundreds of milliseconds. The real-time ring protocol exchanges topological flexibility for recovery times in the tens of milliseconds.

6.10 Ring Setup

Activate a ring by selecting the appropriate **Enable** check box. You can configure one ring for every two ports on the switch.

When a ring is enabled, be sure to choose the two ports being used to connect the switch into that particular ring. To do so, simply pick the available ports from the **Primary Port** and **Backup Port** dropdown lists. Each port should be assigned to only one ring.

The port defined as **Backup** will be blocked under normal operating conditions. By default, the switch with the lowest numbered MAC address in a ring will be the master switch, meaning that the communication in the ring will be blocked from one of the two ring ports of that switch. Only the master switch in a ring does this. You may designate a different switch as the master switch by choosing “This is Master” from the **Ring Master** dropdown list for the desired switch. All other switches in the ring should be set to the default “Automatic” setting.

Note: When a port is configured as a Ring port, that port cannot be used for communication to or through the switch. It can ONLY be connected to another Ring port on a managed switch or Real-Time Ring switch.

REAL-TIME RING SETTINGS

Help

Configure the ring parameters to optimize your network redundancy and maximize reliability.

Enable	Ring Name	Primary Port	Backup Port
☑	Ring 1	port_1	port_2
☑	Ring 2	port_4	port_5
☐	Ring 3	none	none
☐	Ring 4	none	none

Warning: Only one switch may be selected as master.

Ring Master Automatic Master

Commit Changes

Chapter 7 Priority Queuing (QoS, CoS, ToS/DS)

7.1 Traffic Priority

Without enabling special handling, a network provides a “best effort” service to all applications. This means that there are no assurances regarding the Quality of Service (QoS) for any particular application because all packets are treated equally at each switch or router. However, certain applications require deterministic response from the network to assure proper operation.

Consider a drilling machine in a plant that is controlled by a computer elsewhere on a local network. The depth of the machine's drill is critical; such that if the hole is drilled is too deep, the material will have to be thrown out. Under nominal conditions, the drill process is running smoothly (controller and computer are communicating efficiently over the network) but when another user on the network decides to access records from an online database, the large volume of traffic can interfere with timely communication with the drill. A delay in communications between the drill and controller causes the drill to go too far and the material has to be thrown away. To prevent this from happening, we need to provide a certain QoS for all drill-controller communications so delay is avoided.

Numerous mechanisms exist to help assure reliable and timely network communication. The managed switch supports two common means of prioritizing messages: IP header and 802.1p user priorities.

The IP header is present in all frames and contains a priority field, which defaults to 0 and may be set as high as 255. This field is sometimes referred to as the Type of Service (ToS) field, or the Differentiated Services (DS or DiffServ) field.

Applications may add IEEE 802.1p tags, which contain a priority field that may be set from 0 to 7. Each value has a traffic type associated with it. For example, a tag of 5 is prescribed for video data.

The switch provides four priority queues for expediting outbound data. The 256 IP priorities and the 7 IEEE priorities are mapped into these ports in a way that optimizes throughput of high priority data.

7.2 Scheduling

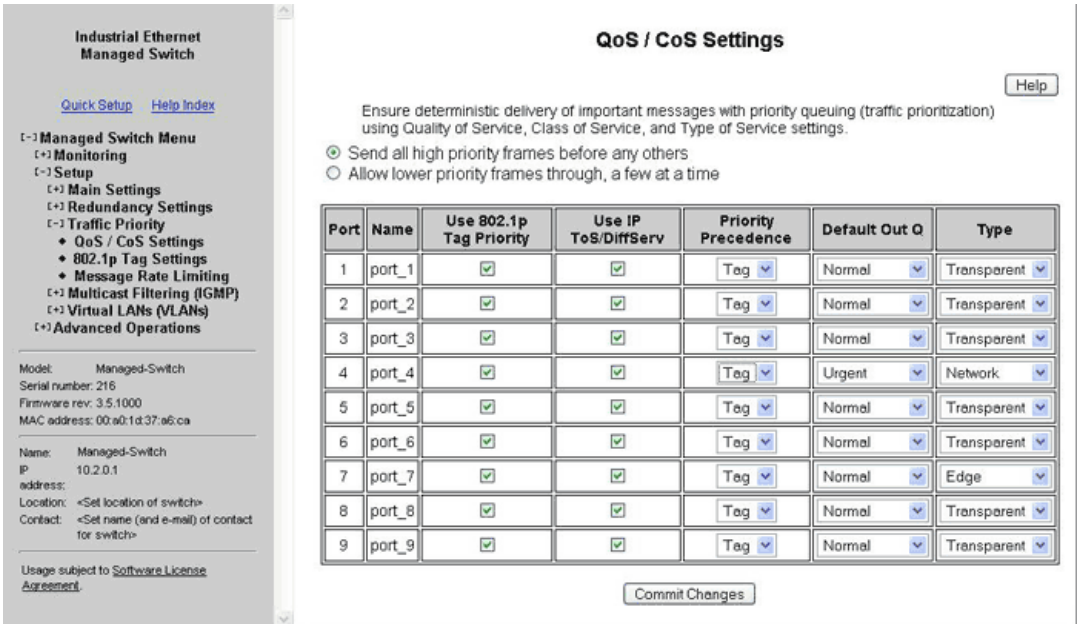
When choosing how to handle lower priority data, the switch can use strict or fair scheduling. This choice affects all queues on all ports.

With strict scheduling, all data in the highest priority queue will be sent before any lower priority data, then all data from the second highest priority, and so on. This assures that high-priority data always gets through as quickly as possible.

With fair scheduling, a round-robin algorithm is used, weighted so that more high-priority than low-priority data gets through Specifically, the switch will send eight frames from the urgent queue, then four from the expedited queue, two from the normal queue, and one from the background queue, then start over with the urgent queue. This assures that the lower priority queues will not be starved.

7.3 QoS / CoS Settings

Access to the switch's traffic priority menus can be done by selecting Setup from the Main Menu, and then Traffic Priority.



For each port, the following settings may be configured:

- **Use 802.1p Tag Priority**: This setting controls whether the switch will honor IEEE tags if present in frames. When enabled, tagged data will be routed to an outbound priority queue based on the configure tag mapping (See below). Disable this setting to ignore IEEE tags on all in-coming frames.
- **Use IP ToS/DiffServ**: This setting controls whether the switch will honor priority fields in the IP header. When enabled, and not overridden by an IEEE tag, data will be routed to an outbound priority queue based on IPv4 Type of Service or IPv6 Traffic Class. The priority queue will be the IP priority field value divided by 64. Disable this setting to ignore IP priority fields.

- **Priority Precedence**: This setting controls which priority mark — IEEE tag or IP header — takes precedence if both are present and enabled. It has no effect if either Use Tags or Use IP is disabled.
- **Default Priority**: This setting controls the default priority to be assigned to frames when it cannot otherwise be determined. For example, if a frame without an IEEE tag arrived at a port where Use IP was disabled. Select an out-bound priority queue from the list.
- **Port Type**: This setting controls how IEEE tags are handled in out-going data:
  - Transparent maintains any tag that may have been present in a frame when it entered the switch.
  - Edge removes tags from all out-going frames.
  - Network adds a tag if none is present. The value of the tag is the queue number times two (six for queue 3, etc.)

7.4 802.1p Tag Settings

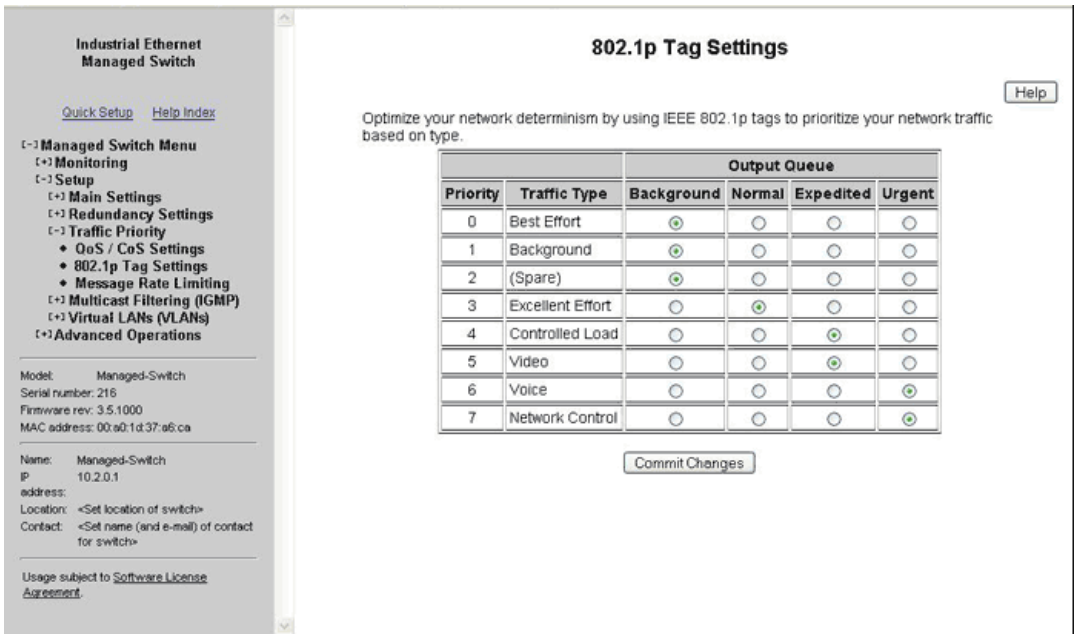
Each of the 8 IEEE tag priority values can be assigned to one of the four output priority queues:

- Background (0)
- Normal (1)
- Expedited (2)
- Urgent (3)

The default assignment follows the IEEE 802.1p recommendation as follows:

Table 7-1 Default Tag Assignments

Priority	Traffic Type	Queue
0	Best Effort	1
1	Background	0
2	Spare	0
3	Excellent Effort	1
4	Controlled Load	2
5	Video	3
6	Voice	3
7	Network Control	3



7.5 Message Rate Limiting

Message Rate Limiting can prevent your switch and network from being overwhelmed by high volumes of broadcast and multicast messages. When enabled on a port, message rate limiting controls the percentage of messages which are allowed to be broadcast or multicast. Messages over the limit are dropped.

Poorly configured applications and devices or malicious users can flood your network with broadcast packets that are forwarded to all ports and can quickly consume most of a network's bandwidth. The managed switch provides some protection from such “broadcast storms” by allowing you to limit the rate at which these messages are accepted by the switch.

For each port, you may choose to limit the rate of broadcast and multicast messages accepted. Messages over the preset limit will be discarded.

7.5.1 Limit Broadcast and Multicast

Limiting is done based on message type and priority. Broadcast and multicast messages are prioritized (e.g., by IP ToS) then limited to approximately the following rates:

Table 7-2 Message Rate Limits

Priority	Limit
Background	10% of link capacity
Normal	20% of link capacity
Expedited	40% of link capacity
Urgent	80% of link capacity

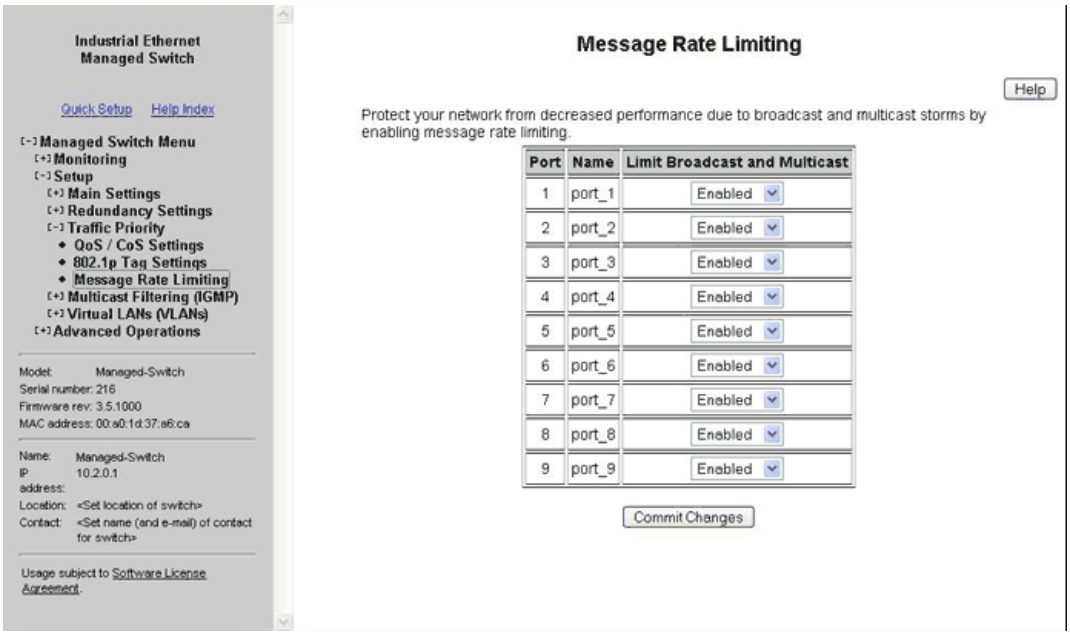
The exact limit depends on link speed.

Messages directly addressed to a single station (unicast messages) are not affected by message rate limiting.

7.5.2 Forward Unknown

By default, messages addressed to unicast addresses that have not yet been learned by the switch are flooded to all other ports. This is important for some protocols that transfer data primarily in one direction, but it can overwhelm smaller systems that do not expect a large amount of traffic.

Forwarding of unknown unicast messages can be disabled on a port-by-port basis by disabling “Forward Unknown”.



7.6 QoS Example

7.6.1 QoS Ensures Real-Time Delivery of Important Messages

Let us investigate a detailed example of how to manage a network such that critical real time data will not be interrupted by data that is not as urgent (relatively speaking). Consider the following:

7.6.2 Hypothetical Scenario

Scenario: There is a power plant that is controlled by a central control system. In addition, because of security concerns, cameras have been mounted and installed at each location of mechanical control. The mechanical control devices and video cameras at each site communicate via Ethernet to their own switch. (For reasons of simplicity and clarity, we will assume that only video and control data reside on the network)

Problem: Should any of the mechanical control devices receive delayed control data from the central control system, the power plant can't generate the maximum energy that it is capable of. Customers will experience brown outs, and the plant will be looked upon with negative scrutiny. It is therefore very important that the video traffic created by the cameras not delay critical data.

Goal: To optimize the forwarding of critical real-time control data and minimize or eliminate the impact of video data traversing the network at the same time.

Solution: Configure the switch such that video data has lower priority than control data by adjusting the priority queuing settings in the switch.

7.7 Configuring the Switch for Traffic Prioritization

As mentioned earlier in this manual, some applications require a certain Quality of Service (QoS) from the network to achieve a desired level of service. In this example, it is important that we achieve timeliness for control data. Without taking advantage of the switch's priority queuing abilities, we are using the best-effort network model. This means that the network will try to deliver all packets of information, but will not make any sort of promise or guarantees with respect to the timeliness of data for specific applications. Considering our control/video example, there is no guarantee that we can get the response time needed for control data if the video cameras are sending data at the same time.

A way to achieve the QoS desired is to prioritize network traffic. Prioritization of network traffic can be achieved even if the devices (video cameras and control systems) do not support selection or configuration of Quality of Service parameters.

Configure all the ports used to interconnect the switches as follows:

Use 802.1p Tag Priority	Checked
Use IP ToS/DiffServ	Checked
Default Priority	Tag
Output Tag	Add Tag

Where the data originates (the camera or control system), configure the QoS/CoS settings for the video camera ports as follows:

Use 802.1p Tag Priority	Unchecked
Use IP ToS/DiffServ	Unchecked
Default Priority	Expedited
Output Tag	Remove Tag

Also, configure the control system ports as follows:

Use 802.1p Tag Priority	Unchecked
Use IP ToS/DiffServ	Unchecked
Default Priority	Urgent
Output Tag	Remove Tag

In this way, the switches will handle the packets appropriately and tag them for handling elsewhere in the network.

At the destination, configure the control system port as follows:

Use 802.1p Tag Priority	Checked
Output Tag	Remove Tag

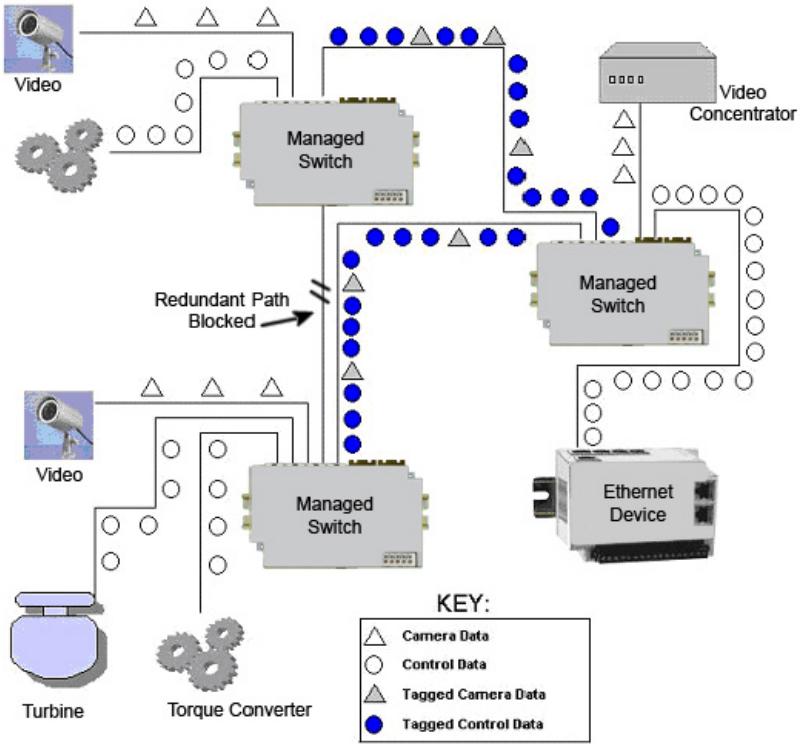
Also, configure the video concentrator port as follows:

Output Tag	Remove Tag

7.8 Result

Result: Configuring the video data to have a lower priority than control data results in the QoS required for the control data.

In the diagram below, we have an IPm controlling a turbine and some torque converters. In addition, we have a video concentrator device that is collecting video data. Since the switch was configured such that video data (Triangles) has lower priority than control data (circles), we see that the control data gets sent out more often than the video data. For clarity, the diagram notes that untagged data in the network consists of open triangles and circles, while tagged data in the network consists of filled triangles and circles. This achieves the QoS needed for the control application.



Chapter 8 Multicast Filtering (IGMP)

8.1 About IGMP

IGMP (Internet Group Management Protocol) allows hosts and routers to work together to optimize forwarding of multicast traffic on a network. Without IGMP, all multicast packets must be forwarded to all network segments. With IGMP, multicast traffic is only forwarded to network segments, which connect interested hosts.

IGMPv1 provides a basic mechanism for hosts and routers to communicate about multicast groups. Routers send Query messages and hosts respond with group membership Report messages.

IGMPv2 adds a maximum response time to the Query and adds a Leave message to the protocol. IGMPv1 and IGMPv2 should not coexist on the same network. Also, IGMPv2 routers are expected to perform IGMPv1 on segments where IGMPv1 hosts are found.

An IGMP snooping switch performs many of the functions of an IGMP router. In passive mode, such a switch processes IGMP protocol messages sent by hosts and routers to configure efficient forwarding of multicast traffic. In active mode, a switch will also send its own queries to speed network convergence.

Periodically, routers and IGMP snooping switches in active mode send an IGMP Query on each attached network. (The query interval is generally around 1-2 minutes.) A host that wishes to be a member of a group sets a timer for a short, random delay when it sees the Query. If it sees a Report from another host before its timer expires, it cancels the timer and takes no further action until another Query is seen. If no other Report is seen, a Report is sent when the timer expires. The router or switch uses the Report to configure multicast forwarding.

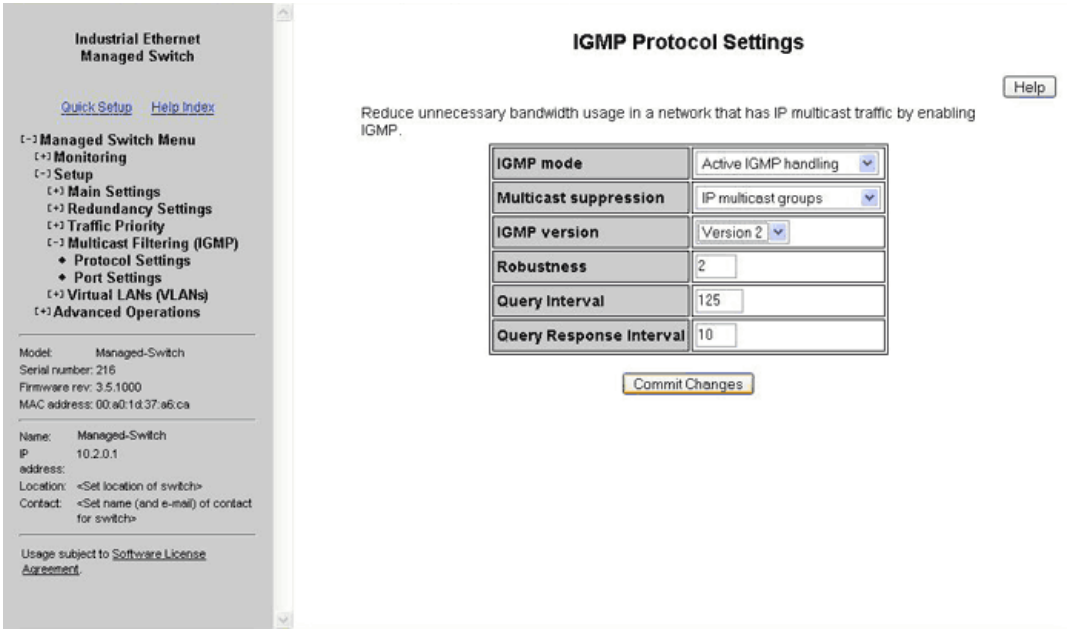
The router or switch keeps track of how long it has been since the last Report on each port for each group. When the group expires, the router or switch stops forwarding multicast data to that port. Since the query interval is less than the expiration time, data for active groups continues to be forwarded without interruption

8.2 Multicast Filtering Configuration

IGMP can be configured through two menus:

- IGMP Switch Settings
- IGMP Port Settings

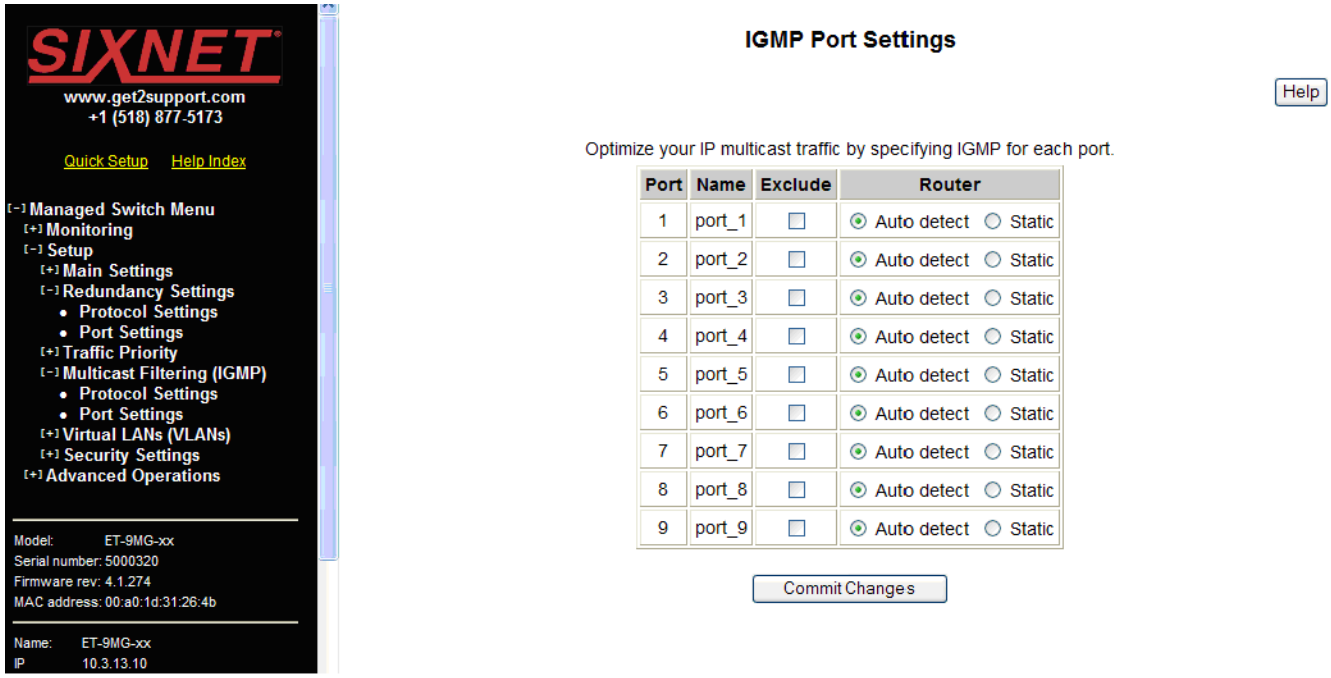
Selecting Setup from the Main Menu and then selecting Multicast Filtering will get you to these menus.



8.3 IGMP Switch Settings

- IGMP Mode: This setting controls how the switch handles IGMP messages to determine how to forward multicast traffic.
  - IGMP Disabled causes the switch to ignore IGMP messages. All multicast traffic will be sent to all ports.
  - Passive IGMP handling causes the switch to listen to IGMP messages and configure forwarding of multicast traffic accordingly.
  - Active IGMP handling causes the switch to act as an IGMP router, sending queries when needed and configuring multicast forwarding according to IGMP membership reports.
- Multicast Suppression: This enhanced feature can intelligently suppress multicast packets that no host has requested with IGMP.

  - **None**–Multicast packets will be sent to all ports unless IGMP is enabled and one or more clients have sent IGMP Report requests.
  - **IP multicast groups**–Multicast packets corresponding to IP multicast groups (with MAC addresses starting 01:00:5e) will be suppressed unless one or more clients have sent IGMP Report messages. Multicast packets with other addresses will be sent to all ports.
  - **All unreserved multicast**–Multicast packets with reserved multicast addresses (01:80:c2:00:00:0x where x is 0..f) will be sent to all ports. All other multicast packets will be suppressed unless one or more clients have sent IGMP Report messages.
- **IGMP Version**: This setting controls the highest IGMP version that the switch will use. All IGMP routers and snooping switches on a network should be configured for the same IGMP version. Select 1 or 2 as appropriate for your installation.
- **Robustness**: This setting specifies how many queries may be lost without impacting forwarding as the switch tries to find IGMP hosts.
- **Query Interval**: This setting specifies how often the switch will send IGMP queries.
- **Query Response Interval**: This setting specifies the maximum time for hosts to respond to IGMP queries. (For IGMPv1, this is fixed at 10 seconds.)



8.4 IGMP Port Settings

Generally, the switch will dynamically learn which ports have IGMP routers attached to them by listening for IGMP Query messages. Under some circumstances, it is necessary to statically configure ports as leading to IGMP routers. Force the switch to forward IGMP messages to a specific port by choosing Static as the router type.

- **Exclude Port**: A port may be excluded from IGMP processing. IGMP queries and reports received on an excluded port are ignored so devices reached via the excluded port cannot join multicast groups filtered by the switch. IGMP queries and reports will not be forwarded to the excluded port so IGMP routers reached via the excluded port will not know of memberships for devices reached by other ports.
- **Static Router**: Specifies whether the switch should assume there is an IGMP router on this port even if no IGMP Query messages are received.

8.5 IGMP Status

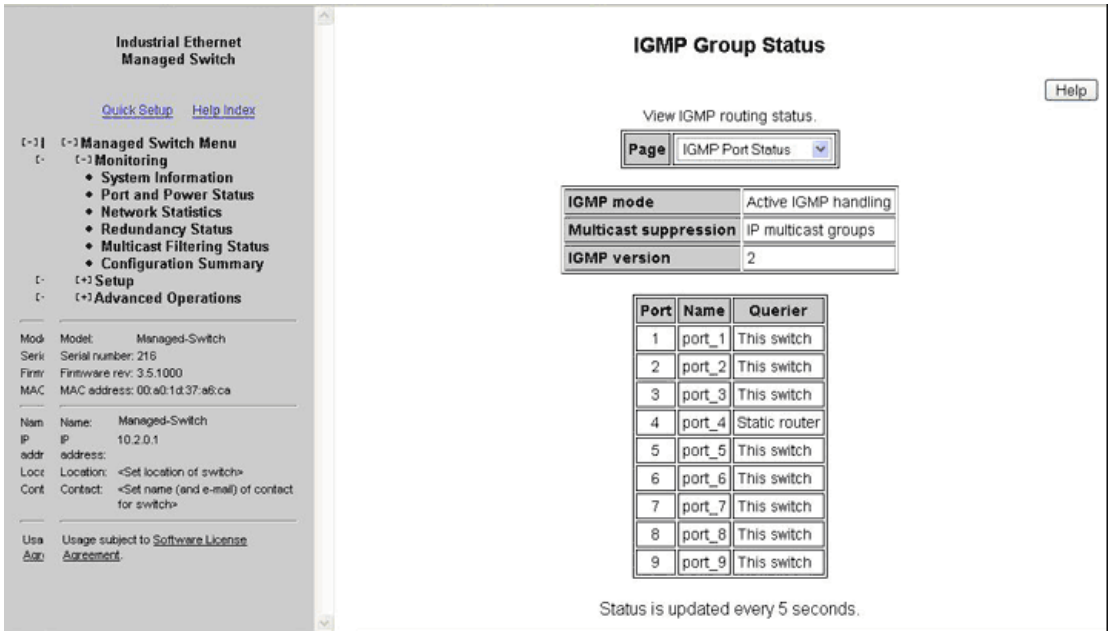
IGMP status can be monitored via two menus:

- IGMP Port Status
- IGMP Group Status

Selecting Monitoring from the Main Menu will get you to these menus.

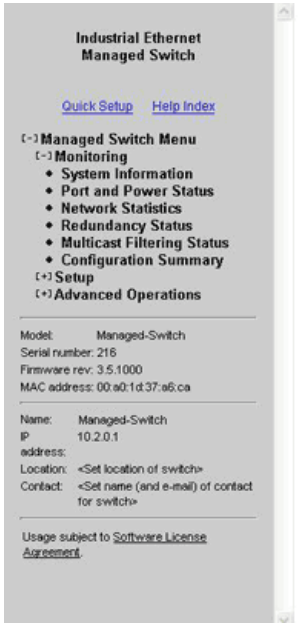
8.6 IGMP Port Status

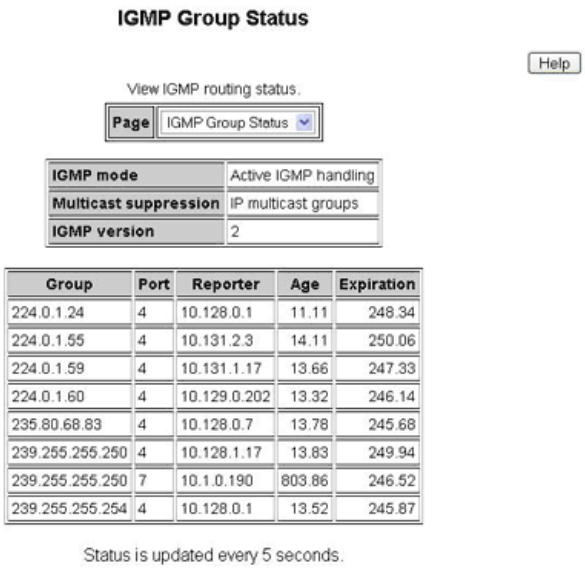
Each network segment can have only one active IGMP querier, the active switch or the IGMP router with the lowest IP address. This screen shows the IP address of the querier on the network segment attached to each switch port.



8.7 IGMP Group Status

Use the group status screen to find out the IGMP groups being forwarded by a switch. There is one line for each group/port combination. That is, if a group is active on more than one port, each port will have a separate line in the table.





The displayed data is separated by several fields:

- Group: Displays the IP address of a particular multicast group.
- Port: Displays the port number for which the particular multicast group is active on.
- Reporter: Displays the IP address of the last host to report membership in this group on this port. Hosts send IGMP Reports to a switch or router for the purpose of having the switch or router include them into a particular multicast group.
- Age: The number of seconds since this group was last reported on this port.
- Expiration: The number of seconds until this group will be dropped unless a new report is received

8.8 IGMP Example

8.8.1 The Benefits of Enabling IGMP

Take an already established control network that has an Ethernet device sending multicast data to several other Ethernet devices. Between the source of the multicast data, and the destination Ethernet devices that are interested in the multicast data, multicast packets might pass through a number of switches or routers.

To make this control network more efficient, the switches or routers should know how to handle the flow of multicast data by means of IGMP (Internet Group Management Protocol). Switches or routers

that are not capable of supporting IGMP will not know what to do with the multicast data and forward multicast data out all ports. This will slow down the network.

Take a look at the diagram below, where the IGMP server is the source of the multicast data, and the IGMP hosts are the devices interested in receiving multicast data. On the network are two switches, where one has IGMP enabled and the other has IGMP disabled. We can clearly see that the switch with IGMP enabled only forwards multicast data to the interested host (Ethernet Station 2). The switch with IGMP disabled will not know where to send the multicast data; thus Ethernet Stations 4 and 6 unnecessarily receive multicast data even though only Station 5 is the interested host.

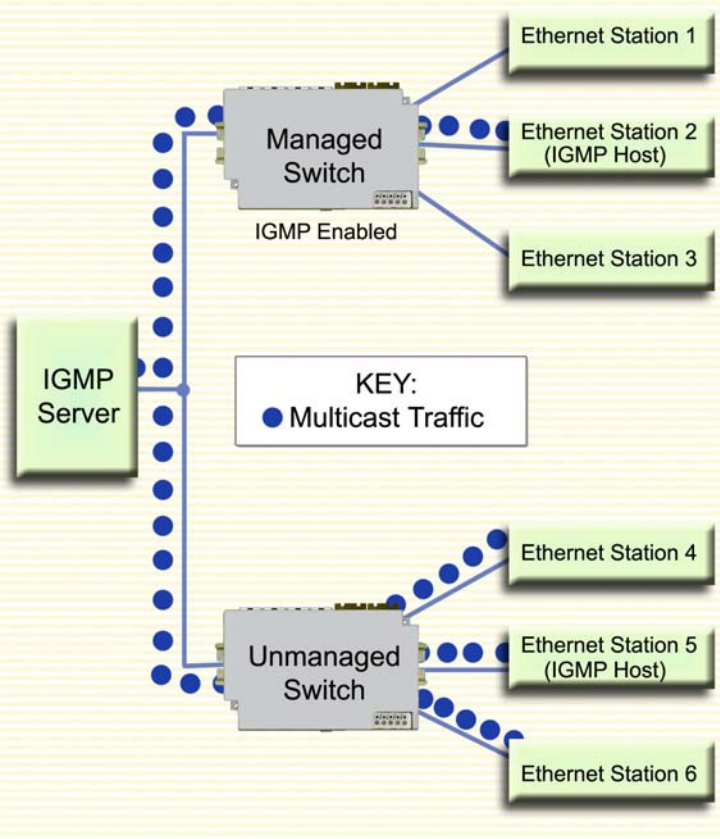


Figure 8-1 IGMP Multicast Filtering Example

Chapter 9 Virtual Local Area Networks (VLANs)

9.1 Introduction to VLANs

VLANs can segregate traffic flowing through a switch to improve bandwidth utilization or security. Segregation is done based on membership in a group of ports (port-based VLANs) or on IEEE 802.1Q tags which include a VLAN ID (tag-based VLANs).

A port-based VLAN limits traffic coming in a port to the group of ports to which that port belongs. For example, on a 9-port switch if ports 1, 3, 5, 7, and 9 were placed in a port-based VLAN, broadcast frames coming in port 3 would be sent to ports 1, 5, 7, and 9 (which are members of port 3's VLAN) but not to ports 2, 4, 6, and 8 (which are not members).

A port may be a member of two port-based VLANs, although results of this configuration are not always desirable or easily predictable. When initializing port-based VLANs the switch configures each port to be able to send data to all ports in all the port-based VLANs in which it is a member. For example, if one VLAN had ports 1-5 and another had ports 5-9, traffic from port 1-4 could go to ports 1-5, traffic from ports 6-9 could go to ports 5-9, and traffic from port 5 could go to all ports.

A tag-based VLAN limits traffic based on the VLAN ID in a 'tag' associated with the frame. VLAN tags may be explicitly placed in frames by applications or switching equipment, or implicitly assigned to frames based on the switch port where they arrive.

VLAN IDs are 12-bits long providing 4096 possible IDs but several values are reserved:

0	Indicates that the tag is not being used for VLAN routing but only to carry priority information. (See QoS / CoS topic in Section 7 of this manual)
1	Used for switch configuration and management.
4095	Not allowed by the 802.1Q standard.

Note: In the SL-5MS-MDM switch the PPP port is a VLAN edge port. Therefore, all VLAN tags are removed.

9.2 VLAN Settings

The **VLAN Settings Menu** can be accessed by selecting **Setup** from the **Main Menu** and then selecting **Virtual LANs (VLANs)**. This menu is used to set the VLAN mode of operation and also create, edit, and remove VLAN definitions.

9.2.1 Choosing VLAN Mode of Operation

There are several VLAN modes, which provide varying levels of flexibility and security. To choose the VLAN mode of operation, select option 1 labeled VLAN Mode. You will be asked to choose one of five VLAN modes:

- **Disabled**–No VLAN processing is done. VLAN IDs and port-based VLANs are ignored.
- **Port-Based**– Only port-based VLANs are used to route frames. VLAN IDs are ignored.
- **Standard**–Port-based VLANs are ignored; all routing is done by VLAN ID. The source port of a frame need not be part of a VLAN for the frame to be forwarded.
- **Secure**–All routing is done by VLAN ID; however, if the source port of a frame is not a member of the target VLAN, then the frame is dropped. For example, if a tag-based VLAN for ID 1024 was configured to include ports 1-5 and a frame with VLAN ID 1204 in its tag arrived at port 6, the frame would not be forwarded.

Caution: If VLANs and redundancy (STP/RSTP/MSTP) are both enabled, situations can arise where the physical LAN is intact but one or more VLANs are being blocked by the redundancy algorithm and communication over those VLANs fails. The best practice is to make *all* switch-to-switch connections members of *all* VLANS to ensure connectivity at all times. See 9.4 VLAN with RSTP on page 81 for more information.

9.2.2 Core Type

Specify the Ethertype for double-tagged (“Q-in-Q”) frames exiting ports of type Core. The value may be specified in hexadecimal with a 0x prefix.

9.2.3 Learning

This setting controls how addresses on different VLANs are learned by the switch.

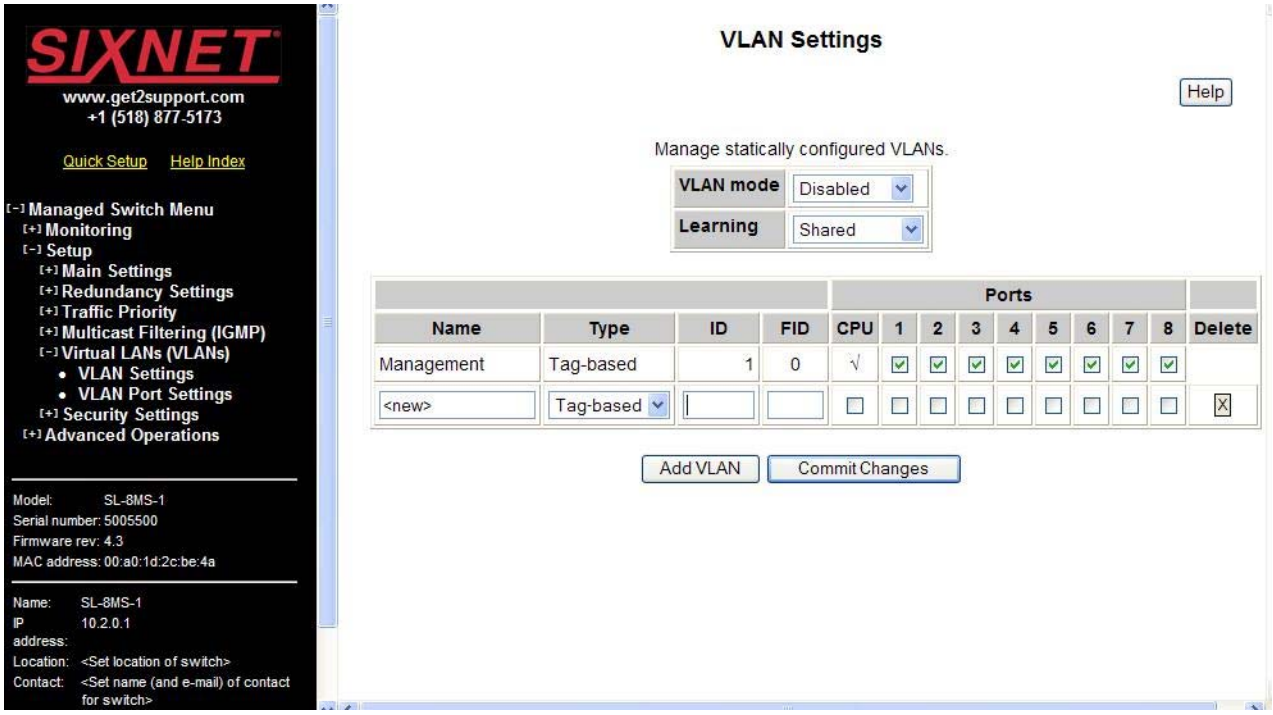
- **Shared**–All VLANs (if MSTP is enabled, all VLANs assigned to the same MSTI) use the same forwarding database.
- **Independent**–The forwarding database used by each tag-based VLAN can be configured independently.

9.2.4 Adding, Editing, or Deleting a VLAN

The switch can handle up to 63 configurable VLANs, and in this menu, each option (starting at option 2) can handle up to 8 VLAN configurations.

For example, there are 16 VLANs defined in the switch. The VLAN settings menu should therefore show a total of 3 options available. The first option is for VLAN mode selection (this option is always

there). The second option allows you to edit VLANs 1 - 8, and the third option will allow you to edit VLANs 9 - 16. Since there are a total of 63 possible VLAN configurations, the VLAN settings menu could show up to 9 available options for you to choose from (the last option will always end with "New" for the creation of a new VLAN). Selecting an option (2-9) displays a page similar to the one shown below:



Choose an entry in the list that has the word <new> as the descriptor, and you will be presented with five options to choose from:

- **Name**: A mnemonic name for a VLAN such as "Cell 7", "Line 4", "Building 58". This is used for display only.
- **Type**: The VLAN's type, port-based or tag-based.
- **ID**: For tag-based VLANs, the ID to look for in the tag. This ID identifies the individual VLANs you create on your network. The VLAN ID must be specified in the range from 2 to 4094. For example, in the screen shot above, the Engineering VLAN ID is 56.

  Note: Take care when setting the management VLAN ID. If the device you are configuring from cannot work with VLANs and the port it is connected to does not have the proper PVID and port type setting the management VLAN may make the switch inaccessible and require a local serial connection to reconnect.

- **FID**: For tag-based VLANs, the forwarding database to use when independent learning is enabled. If MSTP is running, all VLANs in the same MSTI must be configured to use the same forwarding database in independent learning mode. Shared learning automatically assigns a different forwarding database to each MSTI.

  This filtering ID allows multiple VLANs to be grouped for easy filtering in the MAC address monitoring page.

There are three reserved VLAN IDs (that should not be used):

- VLAN ID of 0 is used to identify frames whose tags carry only priority information.
- VLAN ID of 1 is normally used for switch configuration and management

Note: On Gigabit model switches (EK/SL-xMG) the management VLAN ID is configurable by changing the Management VLAN ID from 1 to the number of your choice.

- VLAN ID of 4095 is not allowed by the 802.1Q standard.

- **Ports**: The ports included in this VLAN.

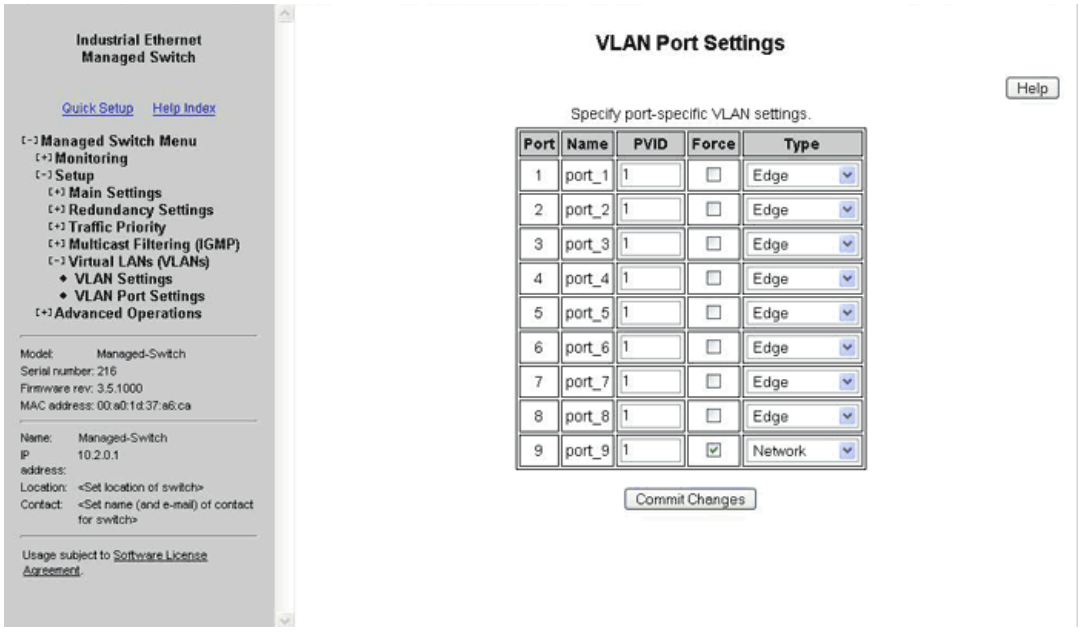
To select the ports to include in this VLAN, check the box for each port you wish to include. Remember that if the "CPU" box is not checked, you will be unable to communicate with the switch from within this VLAN.

Note: When working with tag-based VLANs, ports included in a VLAN may lead to other network devices (which require tags to properly route data) or to end devices, which cannot process VLAN tags. Use the VLAN Port Settings page to configure the appropriate type for each port.

- **Delete**: Select to delete the corresponding VLAN when changes are committed. When selected, this VLAN will be deleted when changes are committed.

9.3 VLAN Port Settings

Each switch port can be configured to control how VLAN tags are handled for frames coming in and going out of the port.



- **PVID**: This is the port's default VLAN ID. It is applied to frames which arrive at the port without a VLAN tag or with a priority-only VLAN tag (one which contains the special VLAN ID 0). Set the desired PVID to make sure your untagged packets for the port get forwarded to other ports in the desired VLAN.

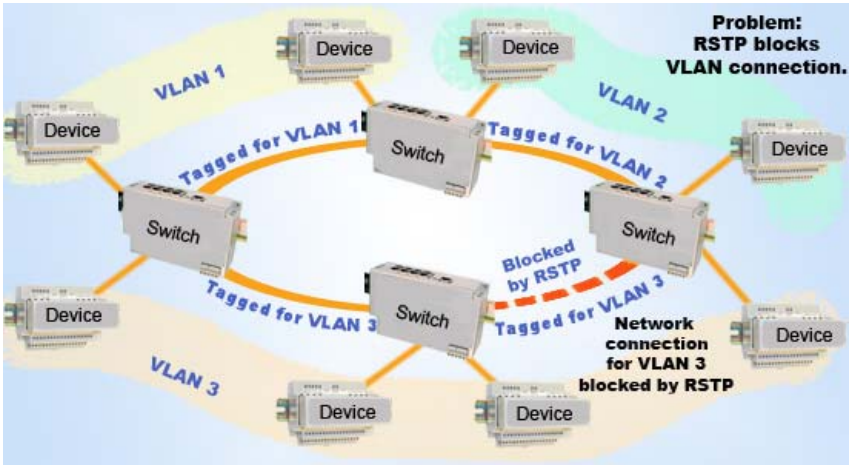
Note: Switch management and configuration is only possible through the port if the PVID is set to 1 (the default). Setting the PVID to another value prevents the switch from being managed/configured via that port (unless the system you are using to configure the switch can explicitly tag frames for VLAN 1, the management VLAN).

- **Force**: When this is checked, the PVID is forced on all frames coming in this port regardless of any existing tag.
- **Type**: The port type controls how tags are handled on frames exiting this port.
  - **Network**: All frames exiting this port will be tagged. If no tag was present when the frame entered the switch, the source port's PVID will be used. Typically, a Network port will be a member of many or all tag-based LANs on a switch and is used to forward VLAN traffic to another switch which then distributes it to other network segments based on the tags. A Network port can only send packets for VLANs in which it is a member.
  - **Edge**: No frames exiting this port will be tagged. (Use this setting for ports leading to legacy or end devices without VLAN support.)
  - **Transparent**: Frames will be forwarded unchanged.

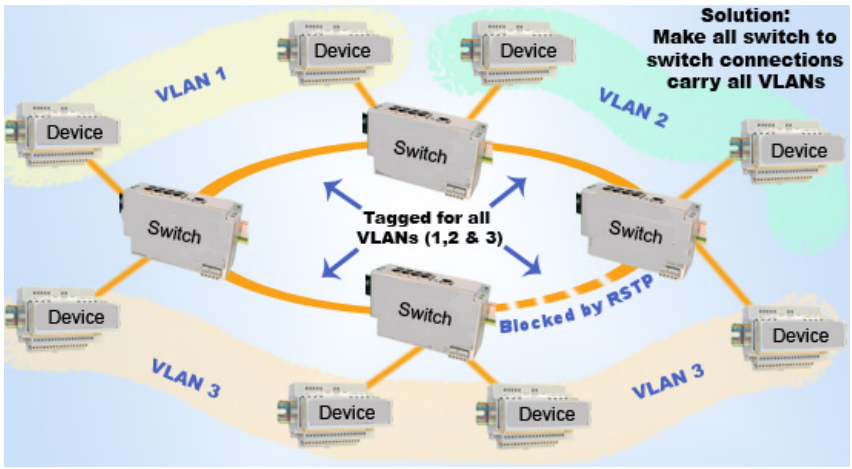
9.4 VLAN with RSTP

Extra care must be taken when enabling both VLANs and redundancy, or communications failures may occur.

The example diagram below depicts the problem with running the Rapid Spanning Tree Protocol (RSTP) and VLANs at the same time. The IEEE 802.1D based RSTP is not aware of the VLAN configuration. Therefore, in the example, one of the Network Ports for VLAN 3 is being blocked (see VLAN Port Settings topic in this section about Network type ports). This prevents VLAN 3 from being able to forward data to all its members.



The solution to the problem above is to configure all “Network” type ports to carry all VLANs in the network. In other words, the Network Port should be a member of all VLANs defined in the switch. As seen from the example diagram below, VLAN 3 can forward to all its members through the other Network Port connections and is not affected by the block RSTP connection.


Solution:
Make all switch to
switch connections
carry all VLANs
VLAN 1
VLAN 2
VLAN 3
VLAN 3
Device
Device
Device
Device
Device
Device
Device
Switch
Switch
Switch
Switch
Tagged for all
VLANs (1,2 & 3)
Blocked by RSTP

Chapter 10 Modem Access Settings (-5MS-MDM Only)

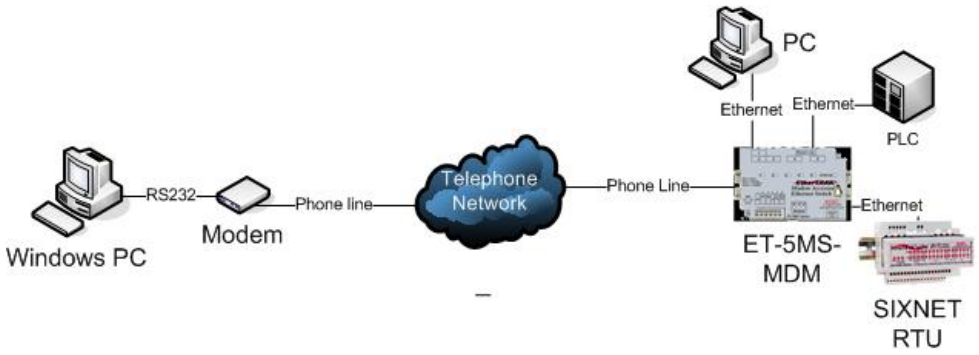
10.1 Introduction to Remote Access

The Point-to-Point Protocol (PPP) can be used to connect two computers or other devices that communicate with “IP” packets via a serial connection, typically using modems and phone lines. PPP is a peer-to-peer protocol which simulates an Ethernet network connection. However, it is convenient and customary to refer to the system placing a call to establish the link as the client and the system receiving the call as the server. Typically, the client must authenticate itself to the server before being granted access.

There are three basic scenarios for accessing an Ethernet network remotely through a modem Dial-in, Dial-out and Site-to-Site. A basic explanation of how each scenario works will be covered in this introduction. For detailed information on configuring a Microsoft Windows PC see Appendix H Remote Access Tutorial (-MDM Models Only) on page 116.

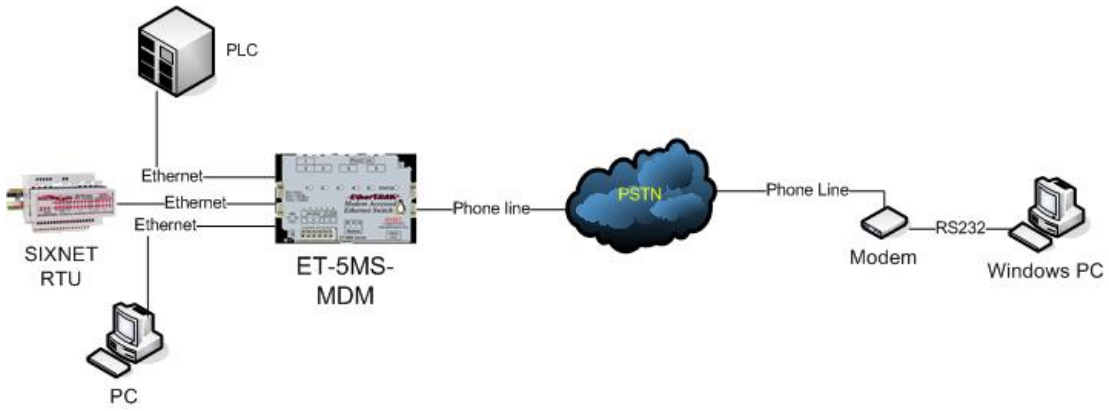
10.1.1 Dial-In

In the dial-in scenario a Microsoft Windows PC will act as a client dialing in to the Ethernet Modem (SL-5MS-MDM) configured as a server in the PPP Settings window. Using Microsoft Windows Dial-up networking and Remote Access Services (RAS) the user will initiate the call. The ET/SL-5MS-MDM will answer the call based on the number of rings that it receives as configured in the Modem Settings page. After the modem-to-modem connection is established the PC will send the preconfigured user name and password to authenticate the client to the server over the phone line. The ET/SL-5MS-MDM will accept or reject that authentication based on its database of users configured in the Remote Users page. When the connection is successfully negotiated the user will be able to access the Ethernet devices connected of off the switch. See the figure below for a graphical representation of the connection.



10.1.2 Dial-Out

In the dial-out scenario a PC, Sixnet RTU or other device generates an Ethernet message destined for a PC. When the ET/SL-5MS-MDM configured for Client Mode in the PPP Settings window receives the message it is buffered until the Ethernet Modem can dial and establish a PPP connection with the Microsoft Windows PC. At that time the message is forwarded on to the PC. See the figure below for a graphical representation of the connection.



10.1.3 Site-to-Site

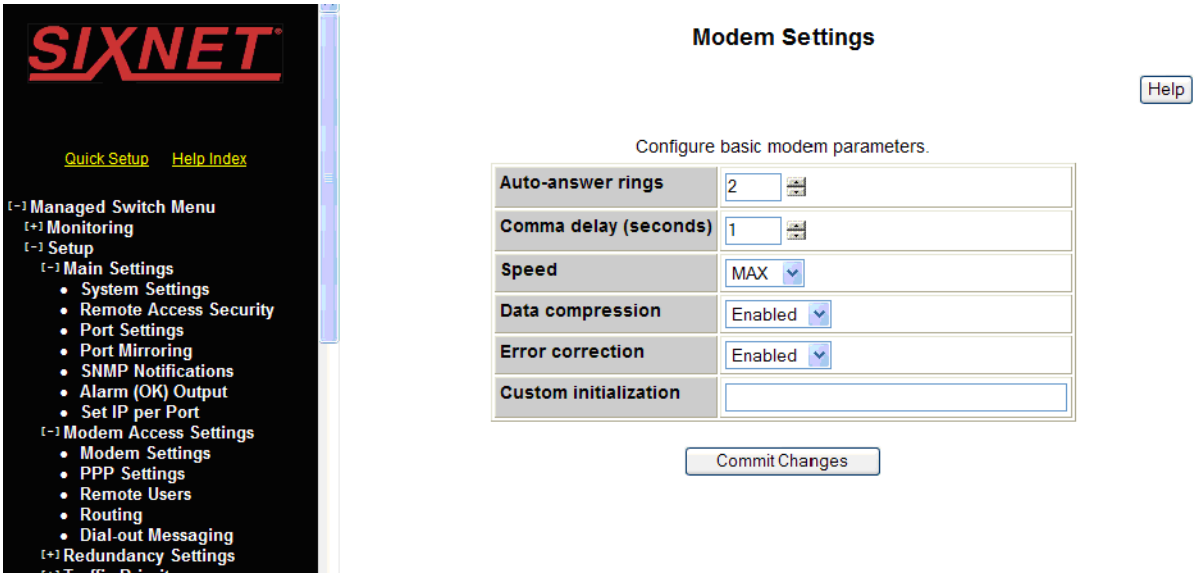
In the site-to-site scenario one ET/SL-5MS-MDM configured for client in the PPP Settings window can call and make a PPP connection to another SL-5MS-MDM configured for Server in the PPP Settings window. This allows systems at both sites to exchange data. See the diagram below for graphical representation of the connection.

Note: Assigning the correct subnet masks and IP addresses in the SL-5MS-MDM and the devices connected to it are essential to routing and dialing. Please see the PPP Settings page for detailed information.

Note: In the SL-5MS-MDM switch the PPP port is a VLAN edge port. All VLAN tags are removed.

10.2 Modem Settings

Set the parameters of the modem for making a modem-to-modem connection.



- Auto-answer rings: (0 to 255, default = 2) Specify the number of rings before the modem will answer the phone. Zero means do not automatically answer. Note: Auto-answer rings must be at least 1 for PPP Server mode and at least 2 for Caller ID security.
- Comma delay (seconds): (0 to 255; default = 1) Specify the number of seconds to delay dialing for commas in phone numbers.
- Speed: (default = MAX) Specify the speed, in baud, to use for modem connections. MAX means use the maximum speed negotiated by the calling and called modem.
- Data Compression: (default = Both) Specify if data compression is used for transmitted data, received data, both, or neither. Data compression is does not work at all speeds and must be used on both answering and dialing modems.
  - None: Disable data compression on the link.
  - Transmit: Use V.42bis data compression technique on transmitted data only.
  - Receive: Use V.42bis data compression technique on received data only.
  - Both: V.42 bis data compression is used bidirectionally.
- Error Correction: (default = Enabled) Specify if error correction is used. Error correction does not work at all modem speeds. When enabled, error correction will be used when appropriate and available.

- Custom initialization: (default = Blank) This field specifies a custom initialization string for the modem that may be used to set some modem parameters in extraordinary circumstances. It must start with AT and may be up to 48 characters. Do not use AT commands E1 and V1 anywhere in your initialization string because the switch needs to disable those features to successfully communicate with the modem.

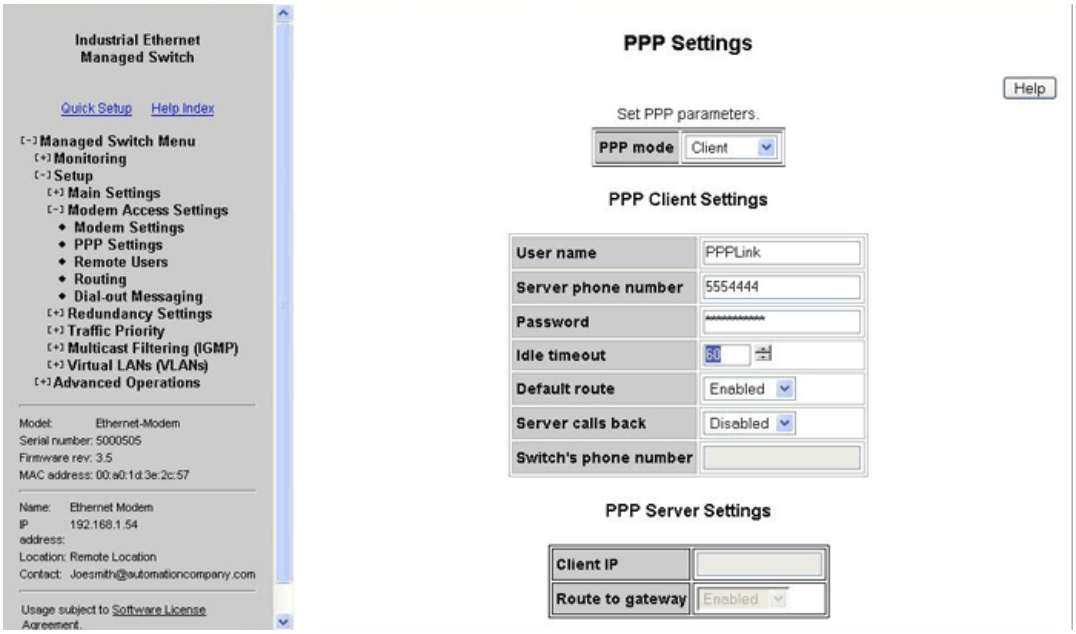
10.3 PPP Mode

Specify whether the switch is a PPP server, PPP client, or neither.

- **Disabled**–The switch will not initiate nor accept PPP connections.
- **Client**–The switch initiates PPP connections to a server.
- **Server**–The switch will accept PPP connections from clients.

10.4 PPP Client Settings

Configure the SL-5MS-MDM to dial a PPP Server when it receives an Ethernet message destined for another subnet.

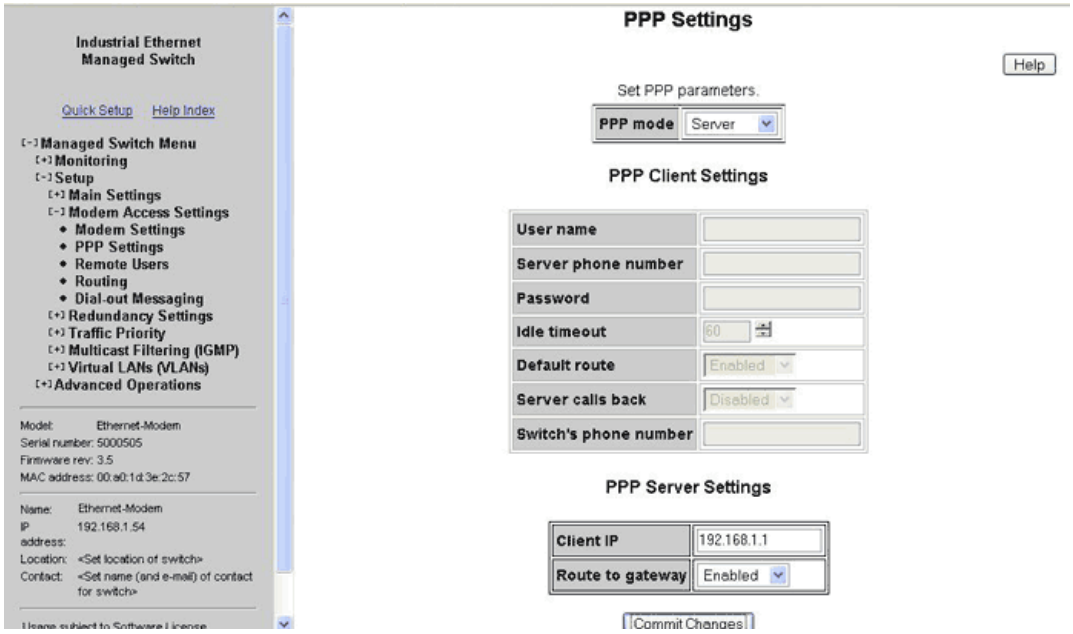


- **User name**: (default = PPPLink) Specify the user name of this client when connection to a PPP server.
- **Server phone number**: Specify the phone number for the PPP server. This should include any prefix such as 9 needed to access the phone line and may include commas to delay between the prefix and the phone number.
- **Password**: (default = Link2Sixnet) Specify the password for this user when connecting to a PPP server.

- **Idle timeout**: (default = 60 seconds) Specify the number of seconds of idle time before a link is automatically dropped. Zero (0) means do not drop the link when idle.
- **Default route**: (default = Enabled) When connected to a PPP server, use the link to the server as a default route.
- **Server calls back**: (default = Disabled) Specifies if the remote system will disconnect and call when this switch initiates a link.
- **Switch's phone number**: (default = Blank) Phone number the server should use to call the switch back. May be left blank if the server is configured to use a specific number for callback.

10.5 PPP Server Settings

Configure the SL-5MS-MDM to answer the call from a PPP Client and give it an IP address.



- **Client IP**: (default = Blank) Enter the IP address that will be assigned the PPP Client when the PPP connection is established. Note: It is recommended to chose a free IP address on the ET/SL-5MS-MDMs subnet.
- **Route to Gateway**: (default = Disabled) When enabled the ET/SL-5MS-MDM will send all messages destined for foreign subnets to its Default Gateway configured in the System Settings configuration page.

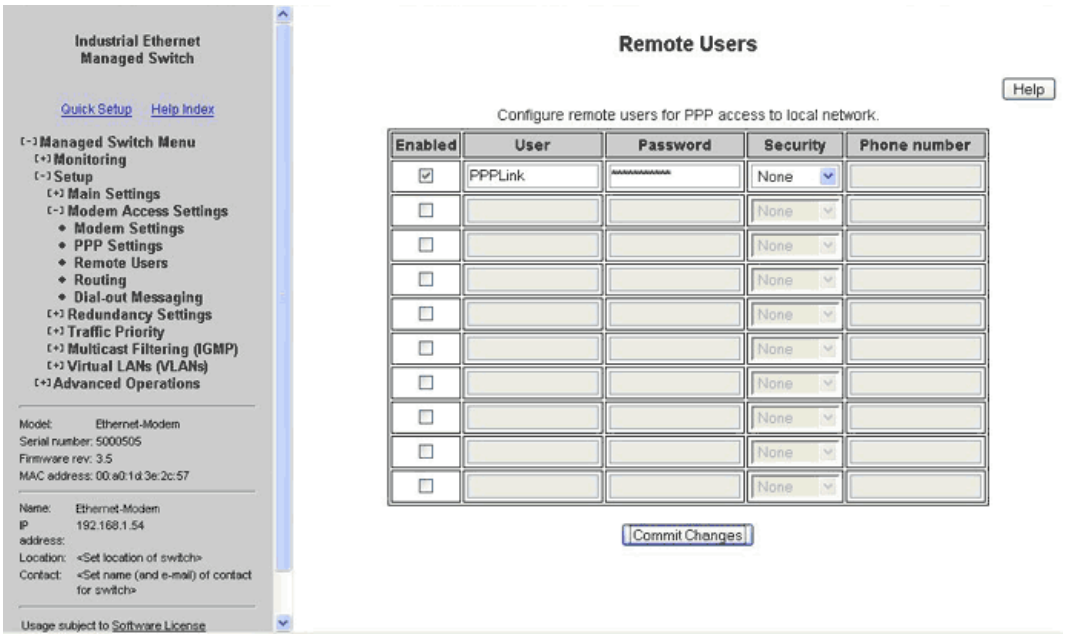
10.6 Configuring IP addresses for Server and Client mode

Configuring the correct IP addresses is critical to ensure the messages are routed through the ET/SL-5MS-MDM correctly. Please keep the following in mind while configuring the switch:

- Dial-In usage scenario: The PC dialing in as the client and the ET/SL-5MS-MDM answering as the server must be on the same subnet mask. When configuring the Client IP in the PPP Settings verify it is compatible (on the same subnet) as the switch and the devices connected to the switch.
- Dial-Out usage scenario: For the ET/SL-5MS-MDM configured as a client to call out it must be on a different subnet as the PC that is receiving the call. When you assign the IP address to the ET/SL-5MS-MDM and the devices connected to the ET/SL-5MS-MDM verify that they are not compatible (not on the same subnet) as the Range of IP addresses configured in Windows PC Remote Access Services (RAS). The Default Gateway in the devices connected to the client ET/SL-5MS-MDM must be set to the IP address assigned to the ET/SL-5MS-MDM.
- Site-to-Site usage scenario: For the SL-5MS-MDM configured as a client to call out it must be on a different subnet as the SL-5MS-MDM that is receiving the call. When you assign the IP address to the Client SL-5MS-MDM and the devices connected to the Client SL-5MS-MDM verify that they are not compatible (not on the same subnet) as the IP address in the Server SL-5MS-MDM and the Client IP in the PPP Setting configuration page. The Default Gateway in the devices connected to the client ET/SL-5MS-MDM must be set to the IP address assigned to the client SL-5MS-MDM. The Default Gateway in the devices connected to the server SL-5MS-MDM must be set to the IP address assigned to the server SL-5MS-MDM.

10.7 Remote Users

Create a database of users that will be authorized to make a PPP connection to the SL-5MS-MDM configured as a PPP Server.



- **Enabled**: (default = Disabled) Enable or disable a user without changing his or her configuration.

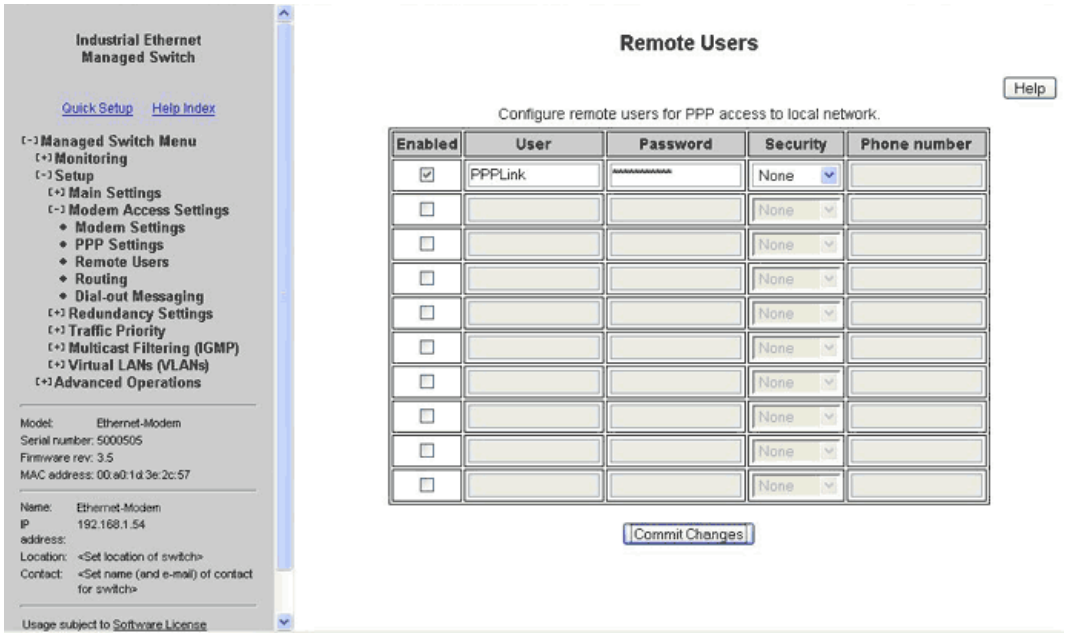
  - **Disabled**–Do not accept calls from this user.
  - **Enabled**–Accept calls from this user.
- **User**: Specify the user name. User names must be unique and may be up to 16 characters.
- **Password**: Specify the password for the user. Passwords are case sensitive, may be up to 32 characters, and may contain letter, digits, and punctuation.
- **Phone number**: Specify the phone number for the user. More than one user may use the same phone number. The phone number may be used to match the number provided by caller ID and may be up to 32 characters.

Security: Choose the security level for this user.

  - None – When the user calls in, the connection will be maintained and the user may use the system.
  - Caller ID – When the user calls in, the connection will be maintained if the calling number matches the configured number.

10.8 Routing

Enable Router Information Protocol (RIP) on the PPP and/or Ethernet Interfaces.

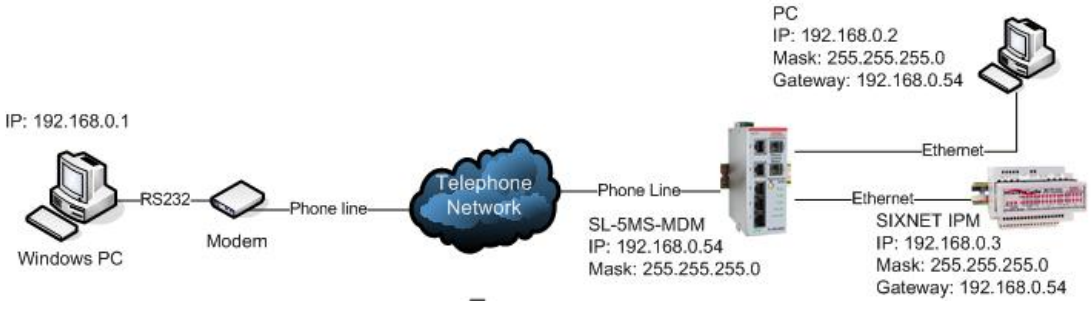


- RIP mode: (default = disabled) Choose to enable/disable the use of the RIP protocol. This protocol is used to exchange routing table information between two ET/SL-5MS-MDMs through a PPP connection, or between one ET/SL-5MS-MDM and one or more router(s) on the Ethernet connection.
- Send: (default = version 2) Select the method the RIP protocol will use to request routing table information.

- Receive: (default = version 2) Select the method the RIP protocol will use to accept routing table information in either responses or unsolicited messages.

10.9 Dial-In Scenario Configuration

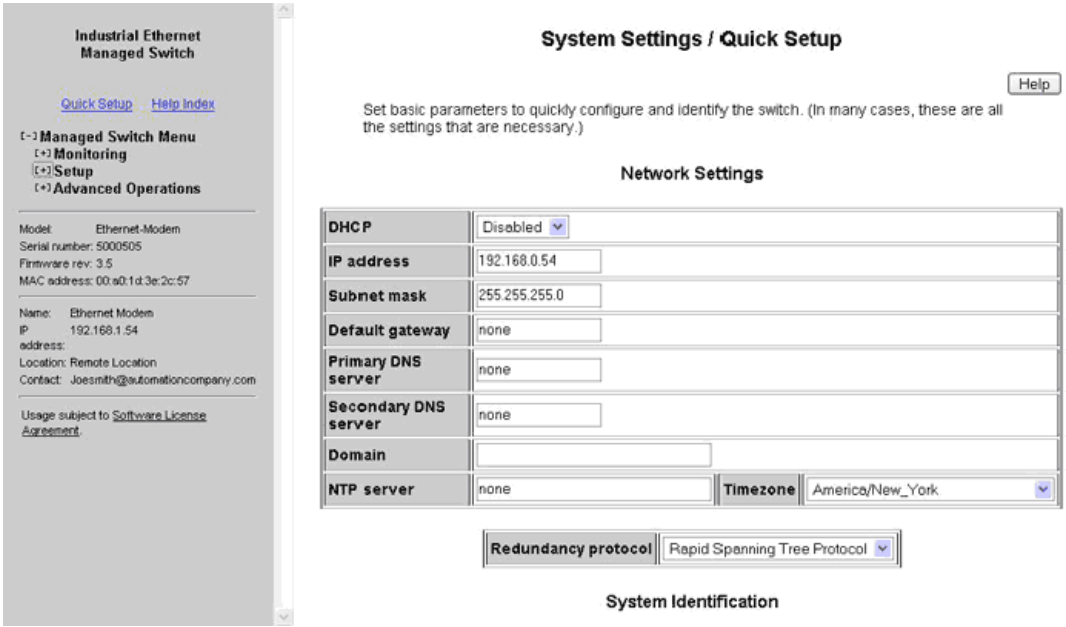
For the typical dial-in scenario, the PC that is calling in (the client), the ET/SL-5MS-MDM that is answering (the server) and the device(s) connected to the ET/SL-5MS-MDM must be on the same sub-net mask. Before you attempt to make a connection make sure all the IP addresses for all the devices are appropriate for the configured subnet. You may also need to set a Gateway in the devices connected to the 5MS-MDM. See the example below.



10.9.1 Configuring a 5MS-MDM as a Server

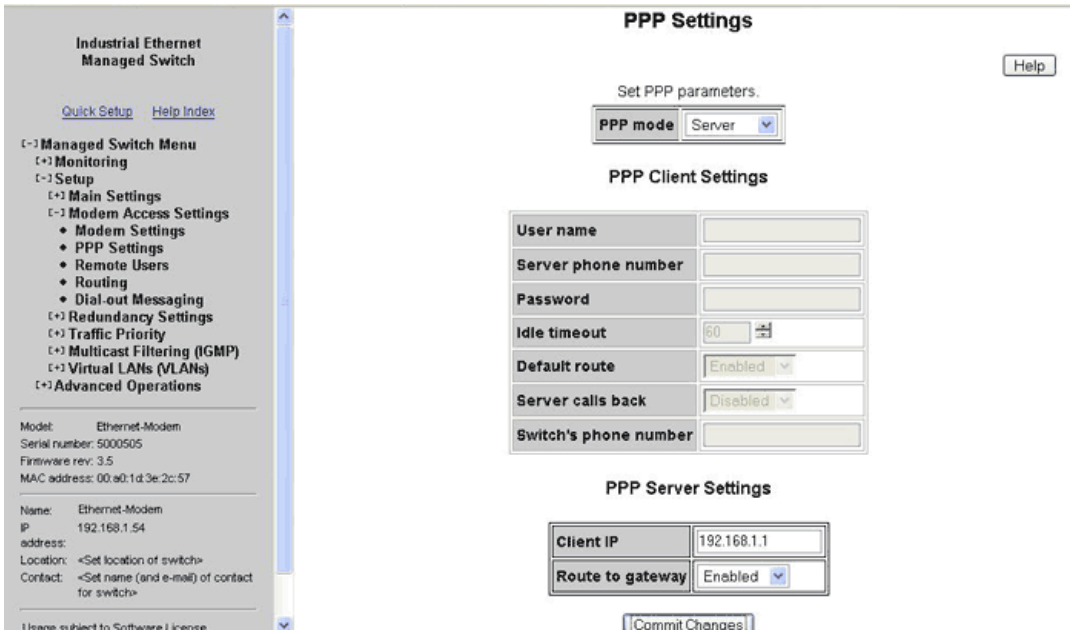
The ET/SL-5MS-MDM, as the Server, will need to assign an IP address to the PC when it dials in, so you must define an IP address that is not being used on the ET-5MS-MDM's LAN. Then a list of remote users must be added so only someone from that list can connect to the Remote Network. Just follow the steps below:

1. The first step is to assign an IP address to the ET/SL-5MS-MDM. To do this go to the Quick Setup page in the ET/SL-5MS-MDM's Text UI (see the screen capture below).

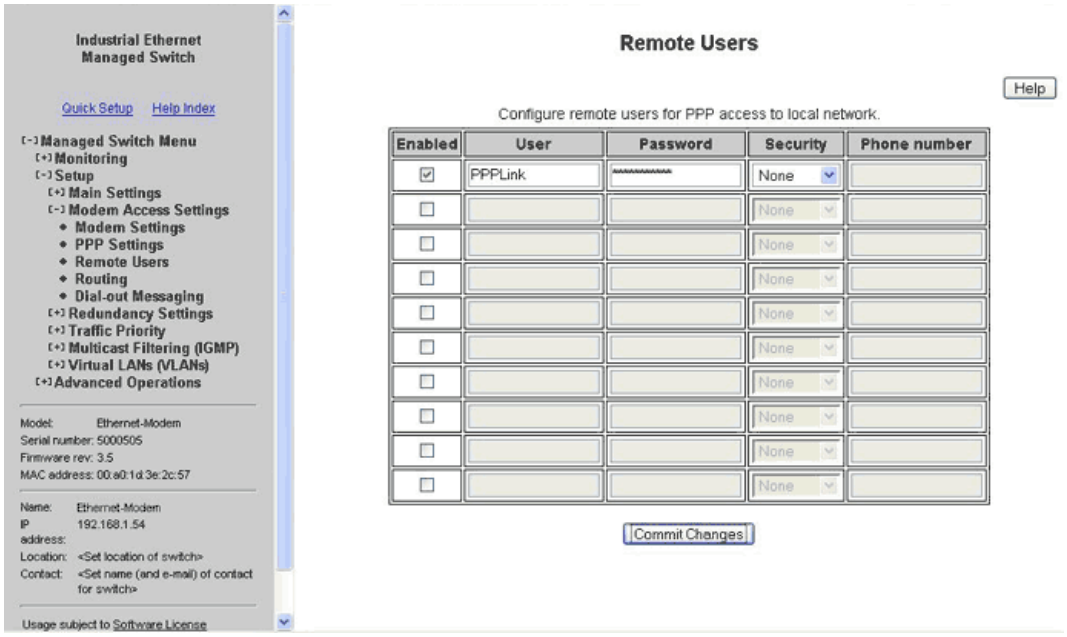


2. Next, go to Remote Access Settings>PPP Settings to set the PPP mode in the ET/SL-5MS-MDM to Server.

3. Then, configure the Server settings to include the IP address that will be assigned to the Windows PC dialing in.



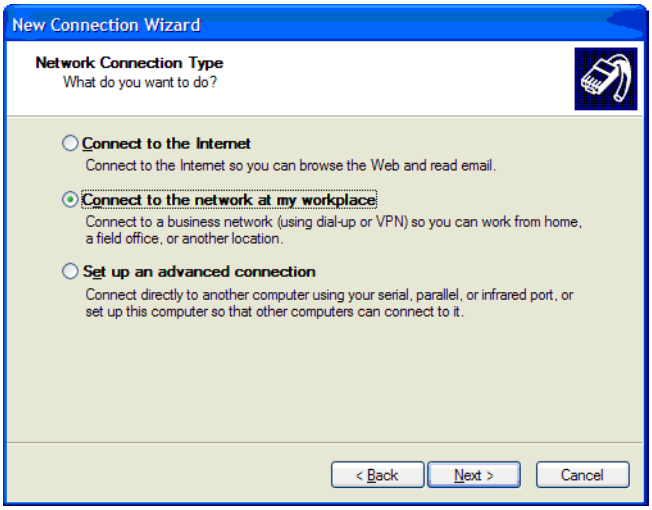
4. Finally, add a list of Remote Users that will be allowed to dial-in and access the remote devices. In this case the default User name of **PPPLink** and password **Link2Sixnet** was used.



10.9.2 Configuring a Microsoft Windows PC as a Client

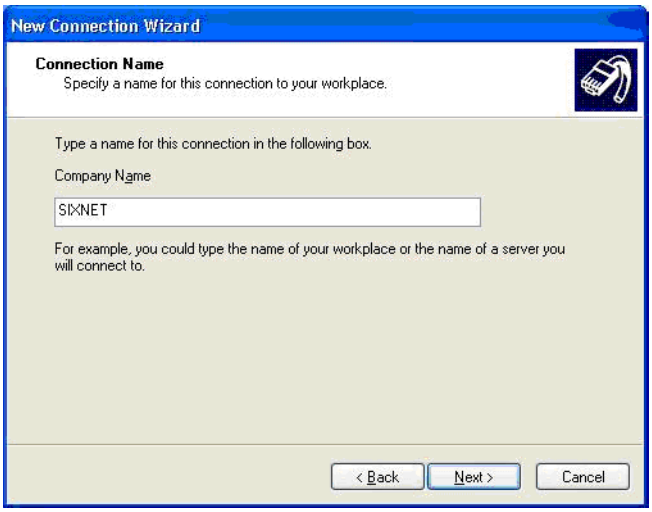
To successfully configure Microsoft Windows to dial you first need to have a modem installed. Refer to the user manual of the modem used for instructions on how to properly install the modem. Then follow the steps below.

1. Go to Microsoft Windows Control Panel and select Network connections.
2. Windows will open a Network Connections window.
3. Go to File>New connection, which will open the new connection wizard.
4. Click the Next button.
5. Select Connect to the network at my workplace. Click Next.

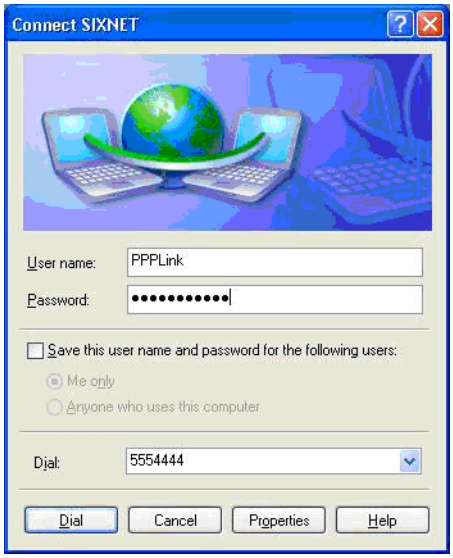


6. Select Dial-up connection. Click the Next button.

7. Enter unique company name for this connection. In this case we will use Sixnet. Click Next.



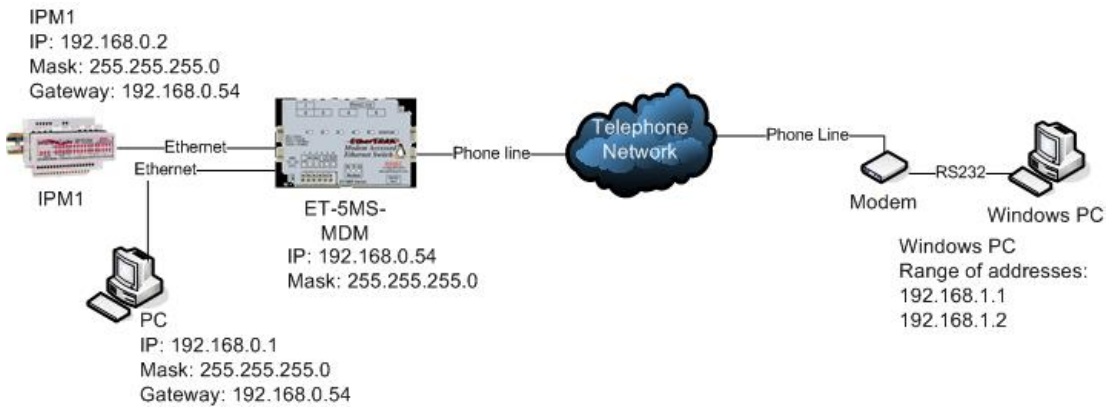
8. Enter in the phone number of the phone line that the ET/SL-5MS-MDM is connected to (the phone number is 5554444 in this case). Click Next.
9. Select the availability of the use of this connection on that computer. Click Next.
10. Click Finish to finish the wizard. A connect window will open.
11. Enter in a username and password that has been configured in the Remote Users page of the ET/SL-5MS-MDM that is being called. In this case the default User name PPPLink and password Link2Sixnet are used.
12. Click the Dial button to initiate the call.



13. When the connection is successfully established the dial-up icon that was created will show that it is connected and you will now be able to access devices connected to the ET/SL-5MS-MDM.

10.10 Dial-Out Scenario Configuration

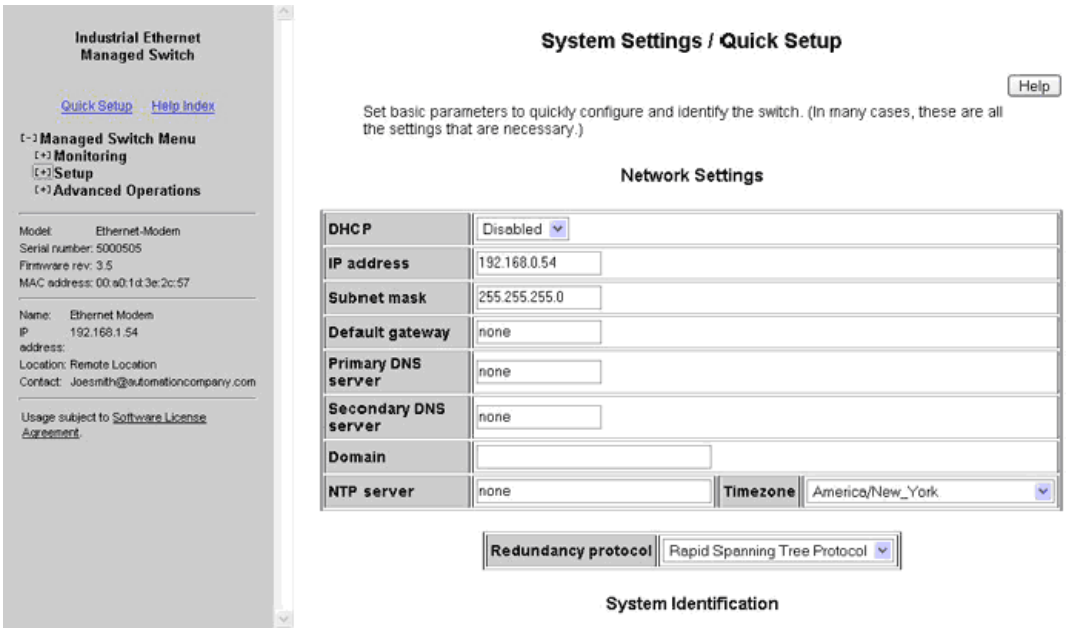
For the typical dial-out scenario, the ET/SL-5MS-MDM that is calling (PPP Client) and the device(s) connected to the ET/SL-5MS-MDM must be on a different subnet mask then the PC answering (PPP Server). Before you attempt to make a connection make sure all the IP addresses for all the devices are appropriate for the configured subnet. See the example below.



10.10.1 Configuring a 5MS-MDM as a PPP Client

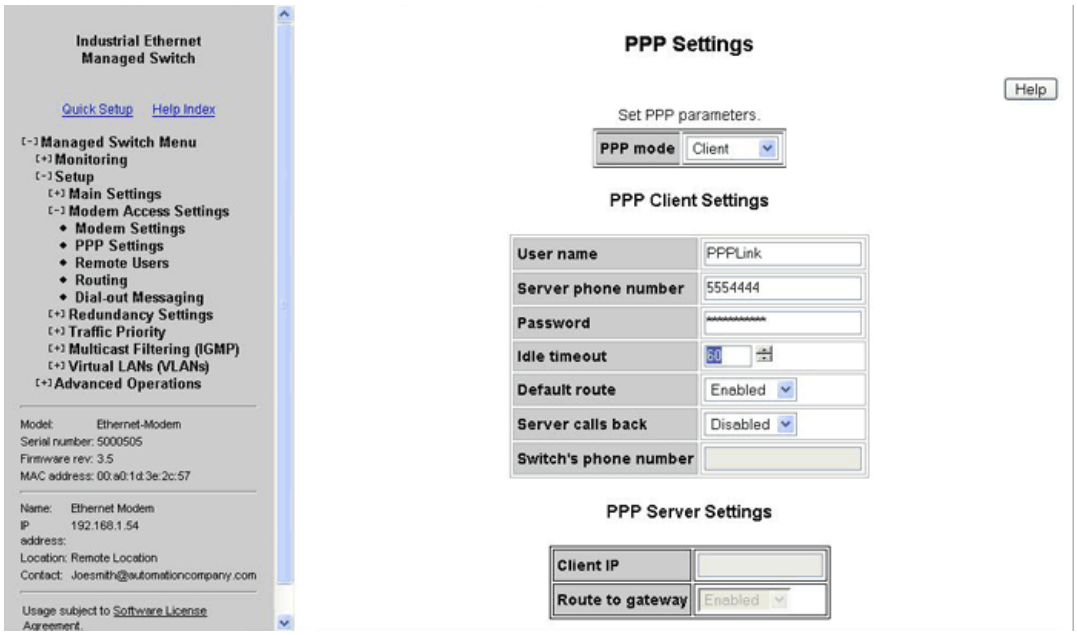
The ET/SL-5MS-MDM-1, as a Client, will call a predefined number when it receives an IP address destined for a foreign network or one that does not have the same IP address scheme. When a PPP connection is established the ET/SL-5MS-MDM-1 will obtain an IP address from the PC configured as a Server on its modem port.

1. The first step in configuring the ET/SL-5MS-MDM-1 is to assign an IP address that matches the IP addresses assigned to the device(s) connected to the Ethernet modem's local LAN (Ethernet) ports. To do this, go to the Quick Setup page of the Text UI (See screen shot below).

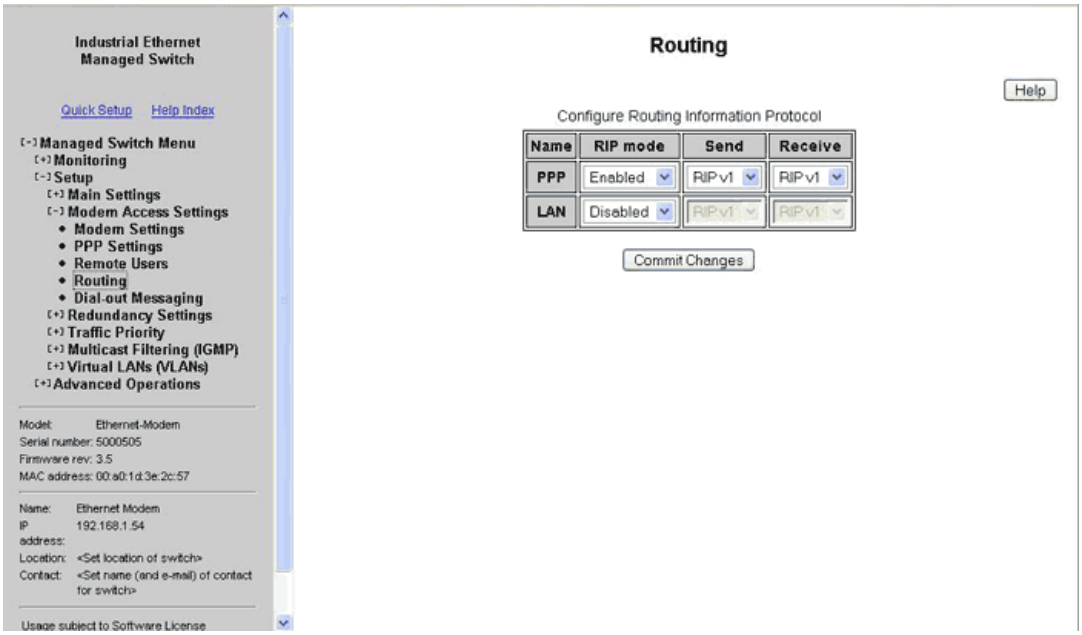


2. Next, the Ethernet Modem should be configured to Client mode so it can know to dial-out and initiate the PPP connection. To do this, go to Setup>Modem Access Settings>PPP Settings and select “Client” as the PPP mode (See the Screen Shot below).

3. Next, the client parameters should be selected. To do this, go to Setup>Modem Access Settings>PPP Settings>Client settings. Set the User name and Password to the same as what the PPP server is configured to accept (the default user name and password is shown below). The Server phone number is the phone number connected to the PPP server. Set Default route to Enabled and Idle Timeout as desired.



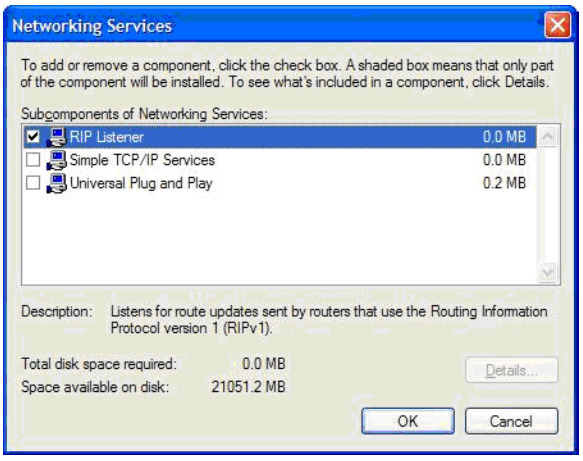
4. Finally, RIP (Routing Information Protocol) version 1 needs to be enabled on the PPP interface so the PC and the ET-5MS-MDM can exchange routing information. To enable RIP go to Setup>Modem Access Settings>PPP Settings>Routing. Set the RIP mode to Enabled on the PPP interface, and select RIP v1 for both Send and Receive (See screen shot below).



10.10.2 Configuring a Microsoft Windows PC as a PPP Server

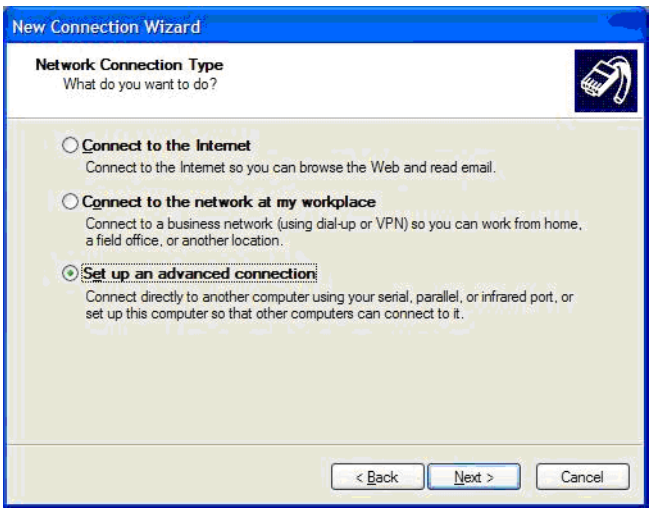
To successfully configure the Windows PC as a Server you should already have a modem installed. Refer to the user manual of the modem used for instructions on how to properly install the modem. Then follow the steps below. The PC must be configured to accept incoming connections and set to enable RIP.

1. To add RIP listener as one of the enabled windows components go to Windows Control Panel.
2. Click on Add or Remove Programs.
3. Click on Add/Remove Windows Components.
4. Highlight Networking Services and click on the Details button.
5. Check the RIP Listener check box and click OK. Click Next then Finish.

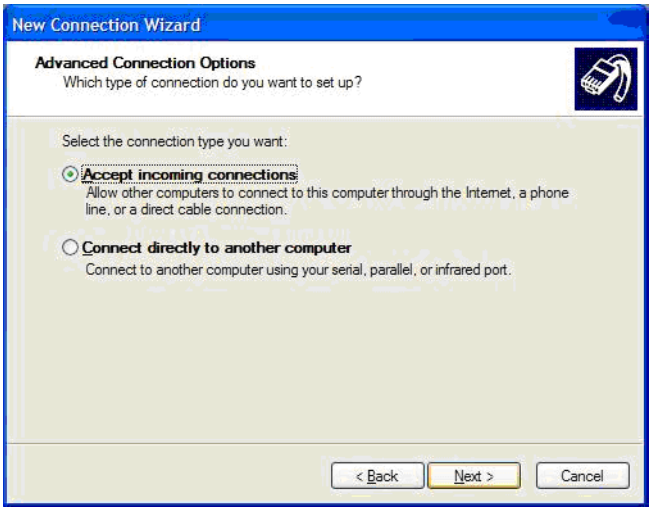


Next, a new incoming connection must be configured so the PC knows to answer the PPP connection. To set up the incoming connection use follow the following steps.

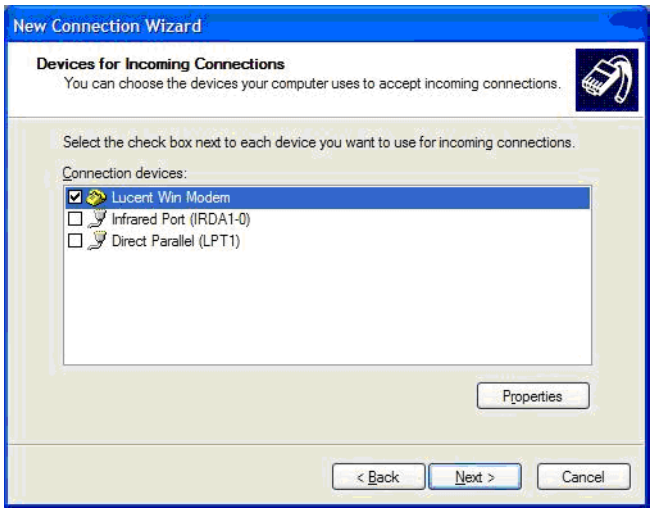
1. Go to Windows Control Panel and Click on Network Connections.
2. To start a new connection go to File>New Connection.
3. When the new connection wizard starts click Next.
4. Select Set up an advanced connection.



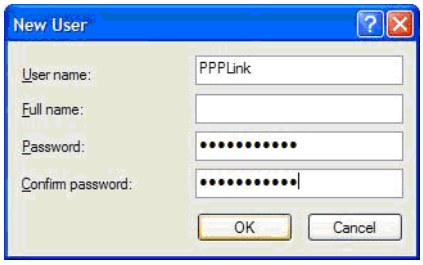
5. On the next page select **Accept incoming connections**.



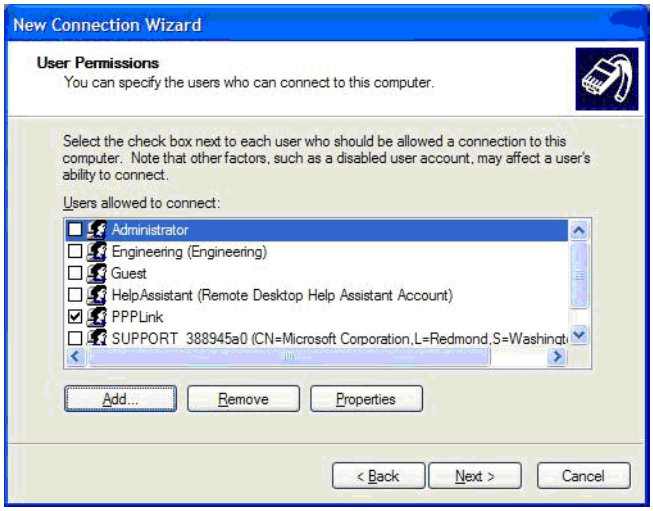
6. Select the modem that installed on the computer that will be answering the call (Lucent Win Modem in this case).



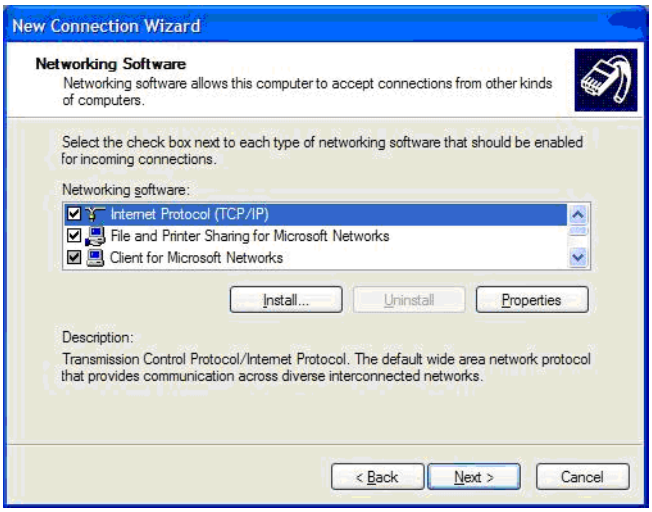
7. In the current user list click on the Add button to add a new user.
8. The User name and Password in the new user should match the user name and Password configured in the ET/SL-5MS-MDM-1. In this case the default Sixnet user name PPPLink and password Link2Sixnet are used.



9. Select the active users that will be used as valid PPP connections. In this case only the new PPPLink user was selected.

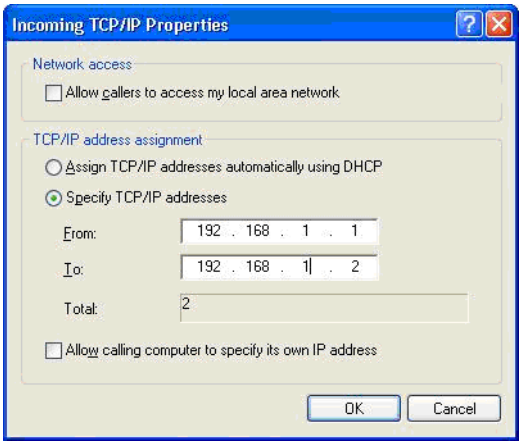


10. Click Next. Select the Networking protocols you will use across the PPP link. In this case all protocols were selected, but only TCP/IP is required.



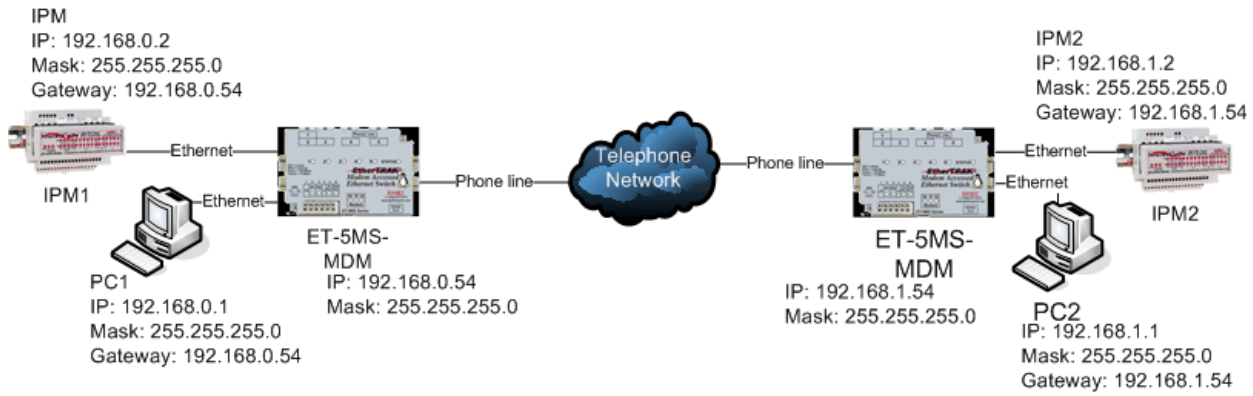
11. Highlight TCP/IP and click on the Properties button.

12. To assign an IP address to your PC and the PPP interface on the ET/SL-5MS-MDM select Specify TCP/IP addresses and enter two consecutive IP addresses in the From and To. The lower of the two addresses will be assigned to the PC and higher will be assigned to the Modem port on the Ethernet modem. In this case 192.168.1.1 will be assigned to the PC and 192.168.1.2 will be assigned to the Ethernet modem.



10.11 Site-to-Site Scenario Configuration

In the typical site-to-site scenario, the Ethernet Modem that is calling (PPP Client) and the Ethernet Modem that is answering (PPP Server) must be on different subnet masks. Before you attempt to make a connection make sure all the IP addresses for all the devices are appropriate for the configured subnet. See the example below.



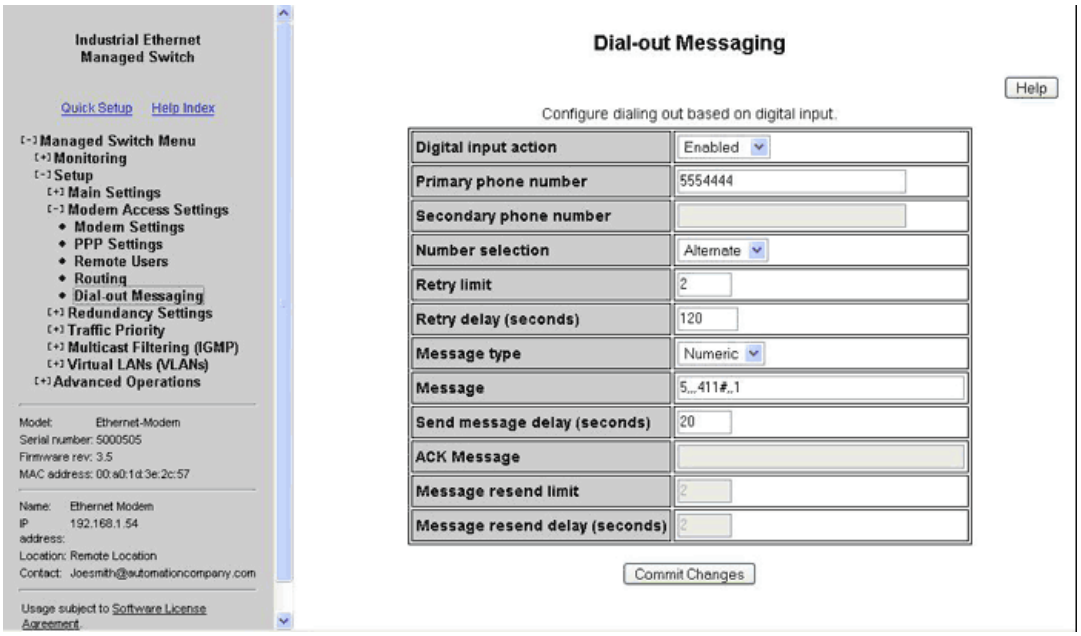
10.12 Introduction to Dial-Out Messaging

Dial-out messaging was intended for a PLC or RTU to send a message to a pager or SCADA PC by simply turning on a 10-30VDC discrete output. In this way the SCADA PC or technician can be alerted of a problem, and call in using the Dial-In usage scenario to connect to SL-5MS-MDM and address the problem. The two methods of alarm in this feature are numeric and serial. A basic explanation of how dial-out messaging works will be covered in this introduction.

- Numeric: When the SL-5MS-MDM is configured for numeric messaging and the 'From PLC' input is energized the predefined number is called and after a pause additional numbers are sent. This is similar to the way the numbers are punched in a phone to call a pager manually. A specific time elapses before the numeric message can be entered. This can alert a field technician of an alarm on the connected PLC.
- Serial: When the 'From PLC' input on the SL-5MS-MDM is energized it will dial a predefined number to another modem. After the modem-to-modem connection is established the SL-5MS-MDM will send a predefined ASCII message to be received by a PC running SCADA software. Optionally, the SL-5MS-MDM will look for an acknowledgement message and reset the message if no acknowledgement is seen.

10.12.1 Dial-Out Messaging Settings

Configure the SL-5MS-MDM to send a numeric or serial (ASCII) message upon an alarm.



- **Digital input action**: (default = Disabled) Specify the action to take when the digital input is energized.
  - **Disabled**–Ignore the digital input.
  - **Enabled**–Dial out and send message.
- **Primary and Secondary phone number**: (default = Blank) Specify the primary and secondary phone number. The value may include digits (0-9) and commas. A comma causes a delay in dialing (as configured in Modem Settings). For example, if you must dial 9 to get an outside line and then wait for a dial tone, the phone number might be configured as 9,,555-1234.
- **Number selection**: (default = Alternate) Specify how the primary and secondary phone numbers will be used for dialing out.
  - **Primary**–Use only the primary number.
  - **Alternate**–Alternate between primary and secondary numbers.
  - **Fallback**–Try the primary number until retry limit is reached then try secondary.
- **Retry limit**: (default = 2) Specify how many times to retry dialing before giving up. If set to zero, the modem will dial once and give up.
- **Retry delay**: (default = 2) Specify long to wait between redial attempts.
- **Message type**: (default = Numeric) Specify how Message is handled after connecting.
  - **Serial**–Send the text specified in Message via the modem after connection. This simulates a user dialing in to a remote modem and typing a message.
  - **Numeric**–Dial the digits in Message to send a numeric page after dialing. This feature is used for numeric paging to pagers and cell phones only. A modem-to-modem connection is not established.

Note: Only the Primary phone number is used for Numeric messages.

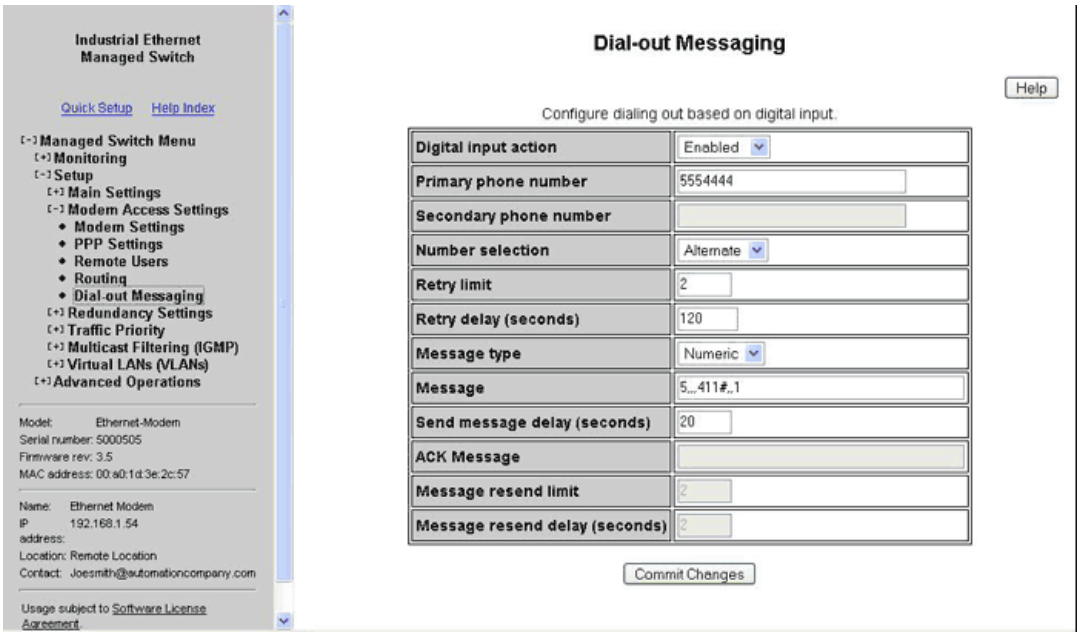
- **Message**: (default = Blank) This is the message to send.
- **Send message delay**: (default = 2) For numeric messages, specify how long to wait after dialing before sending Message. For serial messages, specify how long to wait after connecting before sending Message.
- **ACK message**: (default = Blank) Specify acknowledgement message expected from remote system after sending Message.
- **Message resend limit**: (default = 2) Specify how many times to send Message before giving up. If set to zero, the modem will send the message once then give up.
- **Message resend delay**: (default = 2) Specify how long to wait before resending Message if ACK Message isn't received.

10.12.2 The Ethernet Modem Sends an ASCII Message

This section defines how an ASCII serial message can be sent to a remote computer through a modem by simply energizing the 'From PLC' input on the Ethernet modem. The ASCII message in this tutorial is sent to HyperTerminal (a terminal program distributed with the Windows Operating system), but any program that accepts ASCII messages can be used to receive the alarm message sent by the Ethernet Modem. More information on sending messages to specific devices can be found in technical notes 648 and 649 on http://www.sixnet.com.

All configurations should be done in the **Dial-Out Messaging** configuration window under the **Remote Access Settings** menu.

1. First, set the **Dial-input action** to **Enabled**.
2. Enter the phone number of the modem attached to the answering PC in the **Primary phone number** field.
3. Set the **Message Type** to **Serial**.
4. Enter the desired serial message in the **Message** field. In this example **<RemoteLocation>** to match the Location name of the switch in the system settings, so the destination PC can determine which location is calling in.
5. In this example the **Message resend limit** delay is set to **2** indicating the number of times the Ethernet Modem will send the Message once there is a modem to modem connection.
6. The **ACK Message** is set to **OK** which will be the message that tells the Ethernet Modem to stop sending the message.



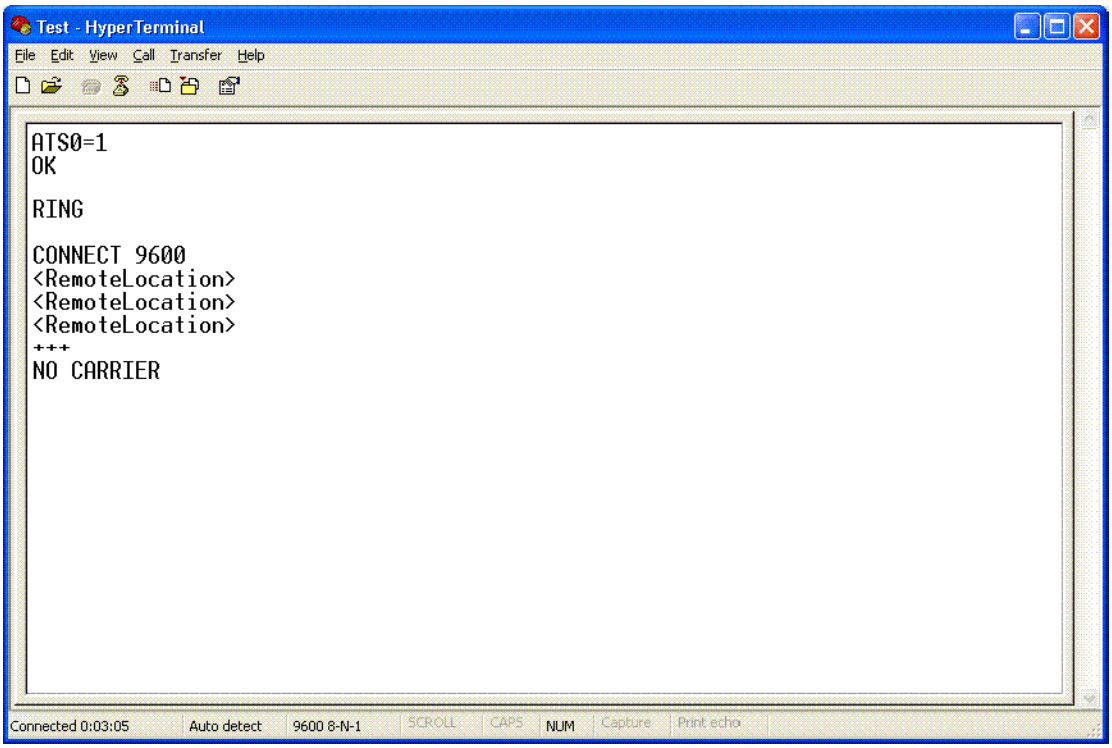
10.12.3 Configuring HyperTerminal

You should already have a modem installed on your computer before you follow the steps below. Otherwise, refer to the user manual for your PC modem for instructions on how to install and set it up.

1. Go to Control Panel>Phone and Modem options to determine the serial port that your modem is connected to.
2. Open HyperTerminal. Normally you can find it by going to Start>Programs>Accessories>Communications>HyperTerminal but this may vary slightly with the PC. Enter a name for your connection.
3. Under **Connect Using** select **Direct to Com "X"**, where "X" is the COM port the modem is connected to.
4. Enter the desired **Bits per second, data bits, parity, stop bits** and **Flow control**. Click **OK**.
5. You should be at a blank screen. Type **ATS0=1**<enter> to verify the modem is set to auto-answer. The modem should respond with an OK (See the screenshot below).

10.12.4 Trigger the Ethernet Modem

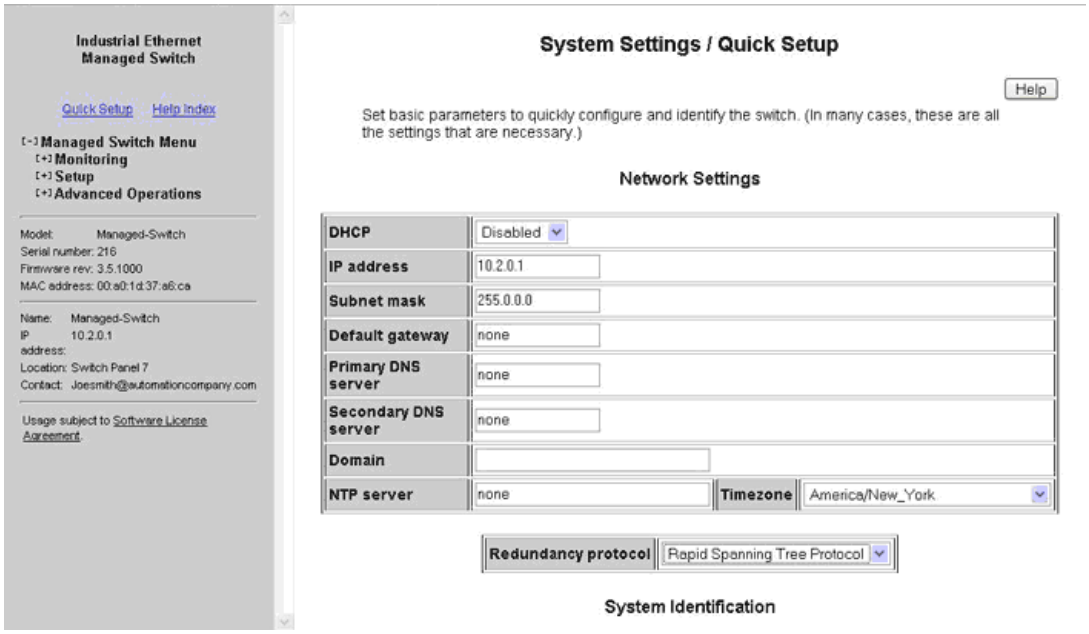
Connect the Ethernet modem to a phone line and apply 10-30 VDC to the **From PLC** input and watch the Hyper Terminal screen. When the message from the Ethernet Modem is successfully sent your HyperTerminal window should look like the screenshot below.


Test - HyperTerminal
File Edit View Call Transfer Help
ATS0=1
OK
RING
CONNECT 9600
<RemoteLocation>
<RemoteLocation>
<RemoteLocation>
+++
NO CARRIER
Connected 0:03:05
Auto detect
9600 8-N-1
SCROLL
CAPS
NUM
Capture
Print echo

Chapter 11 Other Special Features

11.1 Network Time Protocol

You can define an IP address for a time server on your network. On startup, the switch will contact the server you specify to acquire the current time. Then any time stamped information will use this time. You can also define the time zone in which the managed switch resides.

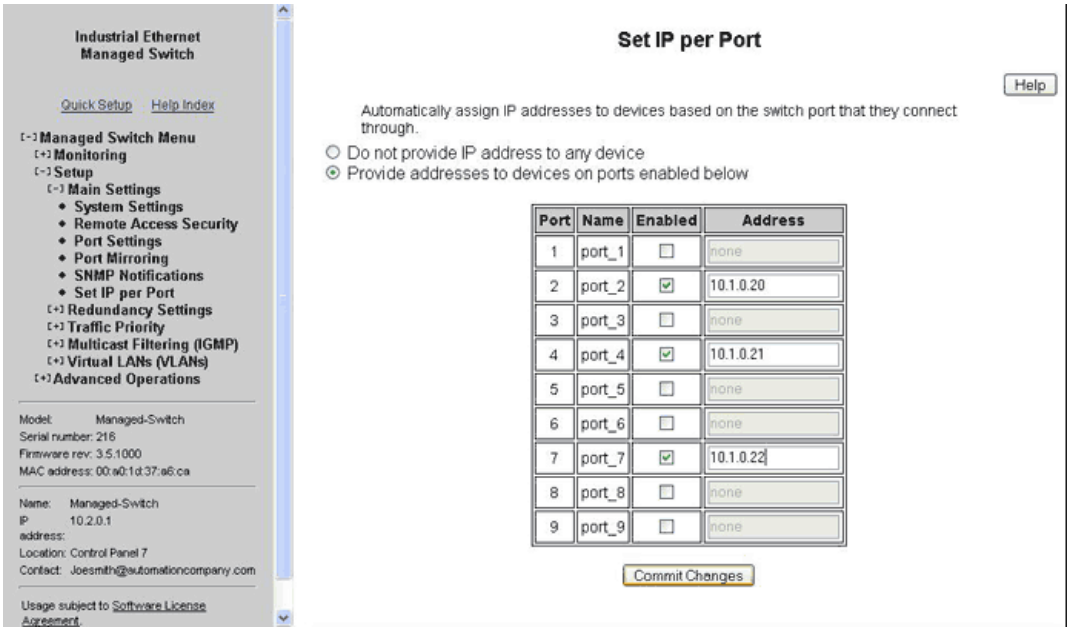


- **NTP server (default = none)**: The IP Address of an NTP server from which the switch may retrieve the current time at startup.
- **Timezone (default = Unset)**: The local time zone such as America/New_York for the East coast of North America.

11.2 Set IP Per Port

The switch may provide an IP address to one device on each network port. This feature may be turned on and off for the whole switch and individually controlled for each port.

The switch responds to DHCP requests by providing a statically-configured IP address to the first device to request one. The DHCP lease does not expire.



- Enabled: When this box is checked, the switch will handle DHCP requests for the port.
- Address: This field specifies the address to provide in response to DHCP requests.

Chapter 12 Security Settings

12.1 Security Overview

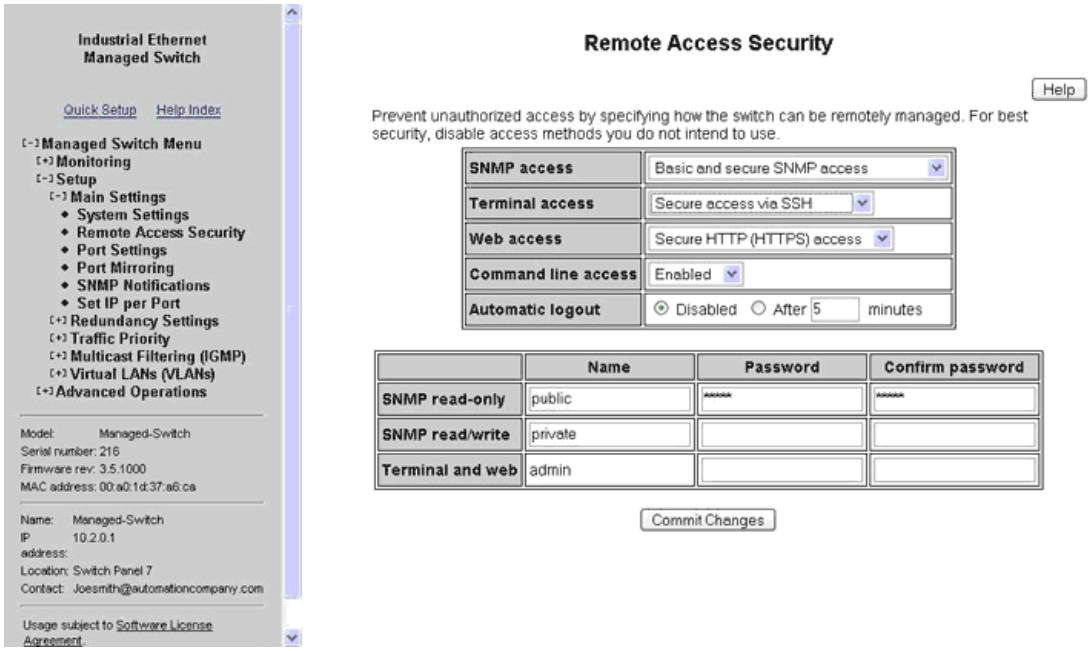
The managed switch offers several ways to secure access to its management functions. It can be remotely managed (monitored and configured) via the following methods:

- **Telnet**–This accesses the terminal or CLI interface (same as you would get through the console serial port) but over the Ethernet network. This type of access offers only password protection (authentication) but no encryption.
- **SSH**–Secure Shell, like Telnet, accesses the terminal or CLI interface over the Ethernet network. It offers both password protection and encryption.
- **SNMP/SNMPv3**–This method access the Management Information Bases (MIBs) using an SNMP server or master utility. Standard SNMPv1 or SNMPv2 has password security. SNMPv3 adds encryption.
- **HTTP/HTTPs** –This method access the web interface. Standard HTTP has password security. The more secure HTTPS adds encryption through SSL (Secure Socket Layers) or TLS (Transport Layer Security).

Note: The best security method is to turn off or disable any access methods that you are not using.

12.2 Remote Access Security

This screen allows you to set your remote access security settings. To access the **Remote Access Security**, select **Setup** from the **Main Menu**, and then select **Main Settings**.



- **SNMP Access**: Choose the level of SNMP access to allow.
  - **None**–No SNMP access allowed.
  - **SNMPv2**–SNMPv2 access with community string sent in clear text and no password required.
  - **SNMPv3**–SNMPv3 access with encrypted password.
  - **Both**–SNMPv2 and v3 access allowed.
- **Terminal Access**: Choose the type of terminal access to allow.
  - **None**–No terminal access to the switch will be allowed.
  - **Telnet**– Non-secure access via telnet protocol. Remote access is possible through this protocol, although all information being transacted between server and client will be sent as clear text.

    Should security be of concern, use the Secure Shell protocol instead.
  - **SSH**–Secure access can be achieved through the use of the Secure Shell protocol (SSH), which implements strong authentication and secure communications using encryption. Using this protocol will ensure that your login information never gets sent as clear text, keeping the switch protected against possible attacks coming from the network.
  - **Both**–The switch can be accessed through secure (SSH) and non-secure (telnet) terminal access.

The switch supports these encryption algorithms for SSH:

- 3DES
- Blowfish
- AES
- Arcfour

To take advantage of the SSH capability in the switch, you will need to use an SSH client program. There are many SSH client programs available for you to log onto the host (the switch).

Two open source SSH client programs are available on the Internet:

- Program Name: OpenSSH for Windows

  http://sshwindows.sourceforge.net/

- Program Name: PuTTY

  http://www.chiark.greenend.org.uk/~sgtatham/putty/

The SSH protocol requires some way for clients to be sure they are communicating with the intended host. The host computes a “fingerprint” based on its key and provides that to the client for verification. The first time a client program sees a fingerprint, it typically displays it and asks something like “The host is offering me these credentials, should I trust it?”

If you agree, the fingerprint is stored for later reuse.

For the system to be secure, the fingerprint used for comparison must be transmitted “out of band” (by a means other than the channel that is being secured by the fingerprint). In this case, via documentation. The RSA fingerprint for the managed switch's encryption key is:

1e:0f:31:39:26:3f:23:8c:ba:7e:e9:d1:56:ff:98:f6

- **Web Access**: Choose the level of web access to allow.
  - **None**–No web access allowed.
  - **HTTP**–Basic HTTP access allowed.
  - **HTTPS**–Secure HTTP (HTTPS) required. Attempts to access the switch via http will be redirected to the secure protocol.
  - **Both**–Basic and secure HTTP access allowed
- **CLI Access**: Choose the level of web access to allow.
  - **Enabled**–CLI access enabled.
  - **Disabled**–CLI access disabled.
- **Automatic Logout**: Specify the number of minutes of inactivity before terminal sessions automatically logout to prevent unauthorized access. The default is 5 minutes.
- **SNMP Read-Only Name**: This parameter sets the SNMPv2 community string and SNMPv3 user name that may be used by SNMP clients for read-only access of settings. Enter your own value if you wish to secure read-only access. (Default is “public”.)

- **SNMP Read-Only Password**: This parameters sets the password for secure SNMPv3 access by the read-only user. SNMP passwords must be at least eight characters long. The default read-only password is 'publicpwd' (w/out quotes).
- **SNMP Read/Write Name**: This parameter sets the SNMPv2 community string and SNMPv3 user name that may be used by SNMP clients for read/write access to settings. Enter your own value if you wish to secure read/write access. (Default is “private”.)
- **SNMP Read/Write Password**: This parameters sets the password for secure SNMPv3 access by the read-write user. SNMP passwords must be at least eight characters long. The default read-only password is 'privatepwd' (without the quotes).
- **New Admin Password**: Password set here is used for Telnet and Web Access. To change the administrative password, select this option. (Default password is 'admin').

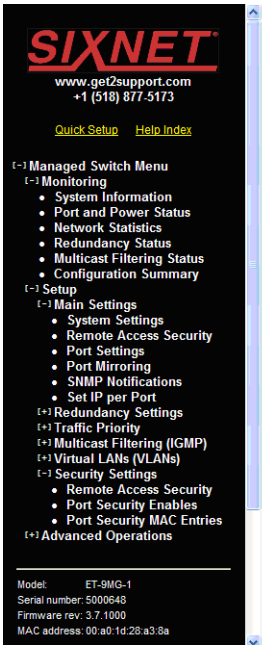
12.3 Port Security

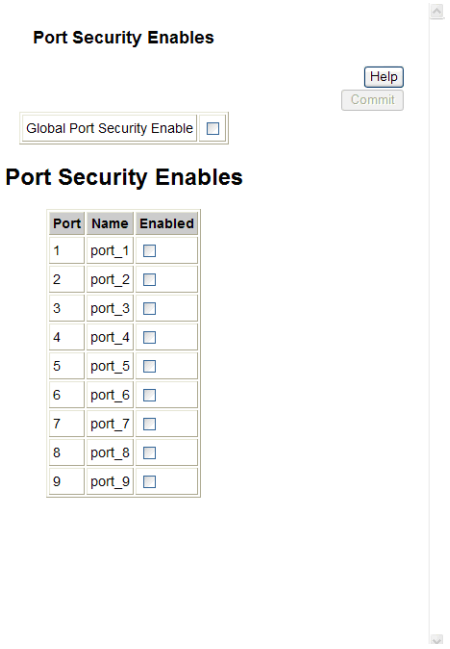
Port Security can be enabled on the MAC address level for additional security. This feature is *not* available in 5MS models.

To turn on port security, check **Global Port Security Enable**. Then choose which ports individual ports should have MAC address security.

When the desired ports are enabled, click the Commit button to commit the changes.

Note: If a port has port security enabled but no MAC addresses are in the MAC entries table, any device connected to that port will be unable to communicate with the switch. Ensure that before security is enabled on all ports, there is at least one MAC address in the table.





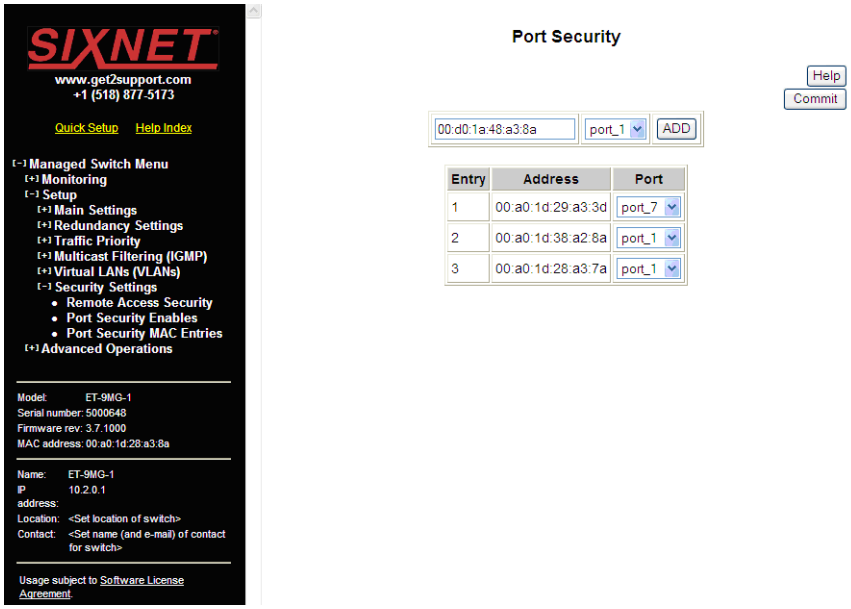
12.4 Port Security MAC Entries

To add a new MAC address to a port, first enter the address. The address must be in a "00:11:22:33:44:55" format. Next, select the port the address will be assigned to. Then, press the ADD button. The address and port assignment will now be in the table, but will not be committed to the switch until the "commit" button is pressed.

To change an existing port assignment for a MAC address or to delete the MAC address, use the port select drop-down box next to the MAC address. This allows you to change the port, or to select "delete". The changes will not be committed to the switch until the "commit" button is pressed.

Note: Once a MAC address is added to a port, it can only communicate to the switch through its assigned port(s).

For example, if MAC 00:a0:1d:38:a2:8a is added to port 1 and is connected to port 2, it will be unable to communicate with the switch.



12.5 IPSEC Settings

IPsec can authenticate, encrypt or compress IPv6 traffic to or from a switch. The IPsec software in this switch only affects management traffic addressed to or sent from the switch, and can only be used when the switch is configured with an IPv6 address.

Warning: Misconfiguration on this screen may block network access to the switch's configuration interface.

Configuration is done via two databases. The SPD sets the required IPsec protocols for traffic going from or to configured hosts or networks. The SAD contains the encryption, compression and hash parameters needed to implement the policies required by the SPD for traffic between specific hosts.

The AH IPsec protocol is used for authentication. It uses cryptography to detect that the sender has the same hash key the receiver does. It does not provide any secrecy in transit.

The ESP protocol is used for encryption. It uses cryptography to hide the contents of traffic in transit from anyone who does not have the secret key it was encrypted with.

IPComp is used to compress traffic. It does not provide any secrecy or authenticity guarantees.

12.5.1 Security Policy Database

This section is used to create, delete, and modify SPD entries.

Caution: Take care when configuring SPD entries. If you do not configure appropriate SAD entries to go along with them and an SPD entry affects the host you are using to configure the switch, you may find yourself unable to communicate with the switch.

To create an SPD entry, click “Add SPD Rule” and set the source, destination, direction, and protocol requirements as appropriate. To save your changes, click Commit Changes.

To delete an SPD entry, click the 'X' button at the end of the row and click **Commit Changes**.

To modify an SPD entry, change parameters as desired and click **Commit Changes**.

Note: SPD entries will not apply to ICMPv6 Neighbor Discovery traffic. This allows Neighbor Discovery to function together with IKE. (Internally, the system adds high-priority rules bypassing IPsec for Neighbor Advertisement and Neighbor Solicitation packets.)

- **Source**–An address of the form address, address/prefixlen, address/prefixlen[port], or address[port]. This specifies the source host or hosts that this policy will affect.
- **Destination**–An address in one of the same forms accepted by the Source field. This specifies the destination host or hosts that this policy will affect.
- **Direction**–The direction traffic is traveling through the switch. If the switch's address is specified in the source field, the direction should be Out. If the switch's address is in the destination field, the direction should be In.
- **ESP**–Whether to require encryption for communication between the specified hosts.
- **AH**–Whether to require authentication for communication between the specified hosts.
- **IPComp**–Whether to require compression for communication between the specified hosts.
- **Delete**–When the button is clicked, this SPD entry will be deleted when changes are committed.

12.5.2 Security Association Database

This section is used to create, delete, and modify SAD entries.

Caution: Take care when configuring SAD entries. If the keys and SPI values are not the same on two communicating hosts and their security policies require encryption or authentication, they will be unable to successfully communicate. You may find yourself unable to communicate with the switch.

To create an SAD entry, click “Add Security Association” and set the source, destination, SPI, mode, cipher, hash algorithm, and keys as appropriate. To save your changes, click **Commit Changes**.

To delete an SAD entry, click the 'X' button at the end of the row and click **Commit Changes**.

To modify an SAD entry, change parameters as desired and click **Commit Changes**.

- **Source**–An address of the form address or address[port]. This specifies the source host (and optionally port) for the security association.
- **Destination**–An address of the form address or address[port]. This specifies the destination host (and optionally port) for the security association.
- **SPI**–A locally unique value identifying this security association. This is assigned locally and may be specified in hex or decimal formats. This should be at least 0x100 (256 decimal) and must be the same on both peers in an association.
- **Mode**–The IPsec mode to use: ESP, AH, ESP and AH, or IPComp.
- **Cipher**–The cipher to use when an ESP mode is selected.
- **Encryption key**–The key to use when ESP is enabled. This must be specified in hexadecimal (beginning with 0x) and should be 24 bytes (48 digits) long for 3DES or 16, 24 or 32 bytes (32, 48, or 64 digits) long for AES.
- **Hash**–The hash algorithm to use when an AH mode is selected. MD5 is not recommended.
- **Hash key**–The hash key to use when AH is enabled. This must be specified in hexadecimal (beginning with 0x) and should be 20 bytes (40 digits) long for SHA1 or 32 bytes (64 digits) long for SHA256.
- **Delete**–When the button is clicked, this SAD entry will be deleted when changes are committed.

12.6 IKE Policy Settings

This screen allows you to configure IKE policy for autonegotiating IPsec Security Associations over IPv6.

Warning: Misconfiguration on this screen may block network access to the switch's configuration interface.

12.6.1 IKE Phase 1 Policies

This section may be used to create, delete, and modify ISAKMP (IKE phase 1) policies. Phase 1 is used to securely authenticate peers.

- **Address**–The address of the peer the policy will apply to. A policy for **"**anonymous**"** will apply to all peers without a more specific policy.
- **Exchange Mode**–The preferred exchange mode is the one that will be sent in any proposal to a peer. If other exchange modes are specified, they will be accepted in received proposals. With Aggressive, the DH Group in the sent proposal must exactly match the peer's configuration.
- **Cipher**–The cipher used to encrypt proposal exchanges. You must choose a cipher.
- **Hash**–The hash used to authenticate proposal exchanges. You must choose a hash algorithm.
- **DH Group**–The Diffie-Hellman group used for exponentiations. Larger groups should be more secure, but may take so long to compute that completing negotiation becomes impossible due to timeouts, preventing connectivity to the switch management interface. This should generally be set to the same value on both peers in a connection.

12.6.2 IKE Phase 2 Policies

This section, together with IKE Phase 2 Algorithms, is used to configure the parameters used to establish Security Associations between peers once they have authenticated each other in phase 1.

The policy to use is selected using the source and destination selectors from the Security Policy Database entry or the ID payload from the received IKE packet which triggered the negotiation. The match for any values other than “anonymous” must be exact.

- **Source**–The source address to match against. The address specified should exactly match the Destination address field in a phase 2 policy on the peer, unless either value is “anonymous”. The value “anonymous” matches sources not handled by other rules.
- **Destination**–The destination address to match against. The address specified should exactly match the Source address field in a phase 2 policy on the peer, unless either value is “anonymous”. The value “anonymous” matches destinations not handled by other rules.
- **PFS Group**–The Diffie-Hellman exponentiation group used for Perfect Forward Secrecy. This may be disabled if not required, but any proposal suggesting it will still be accepted. Larger groups may require an excessive amount of processing time during negotiation, causing timeouts.

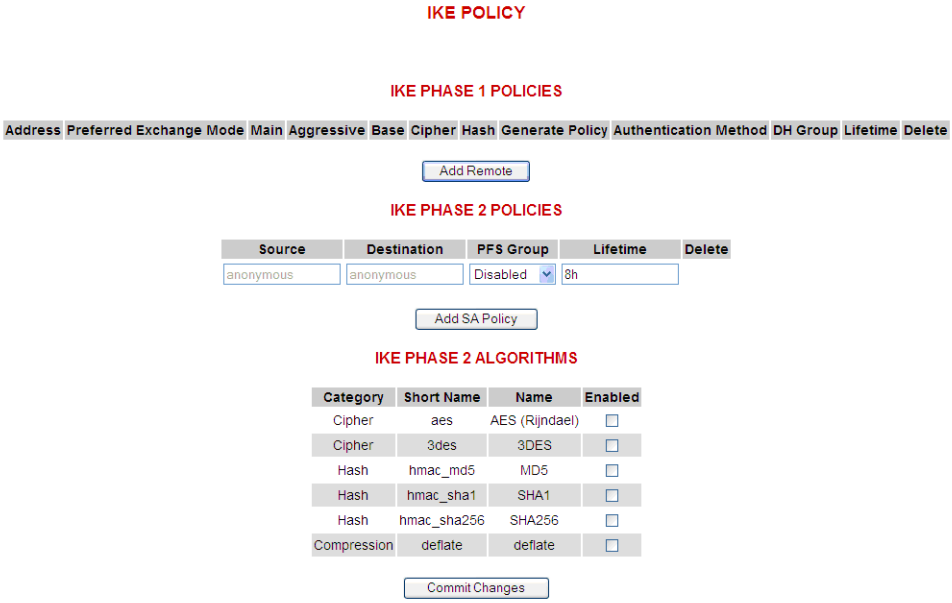
12.6.3 IKE Phase 2 Algorithms

This section is used to configure the algorithms which may be used for phase 2. The exact algorithms chosen will be an intersection between the sets specified here and on a peer.

You must enable at least one algorithm from each category (cipher, hash, and compression), even if the switch's IPsec policies do not require one of the given protocols to be used.

The default values should be compatible with most installations.

AES (default = Enabled)	Cipher	
3DES (default = Enabled)	Cipher	
SHA1 (default = Enabled)	Hash	
SHA256 (default = Enabled)	Hash	
MD5 (default = Disabled)	Hash	MD5 is known to be insecure and is included only for compatibility with old implementations.
deflate (default = Enabled)	Compression	



12.7 IKE Preshared Keys and Certificates

12.7.1 IKE Preshared Keys

This screen allows you to configure IKE PSKs (pre-shared keys) used to negotiate with the IKE peers with which the switch communicates over IPv6.

Warning: Misconfiguration on this screen may block network access to the switch's configuration interface.

The same pre-shared key must be set for both peers. For example, if communicating between two hosts fe80::1 and fe80::2 with a pre-shared key “secret”, fe80::1 must have “secret” set as the pre-shared key for peer fe80::2, and fe80::2 must have “secret” set as the pre-shared key for peer fe80::1.

- **Peer Identifier**–The identifier of the peer with which this pre-shared key should be used. Typically this will be the peer's address.
- **Set Key**–The value to set the pre-shared key to. If left blank, the current value will be preserved.
- **Delete**–Mark this pre-shared key for removal when changes are committed.

12.7.2 IKE Certificates

This screen allows you to configure IKE certificates used to identify the switch and IKE peers with which it communicates over IPv6.

Warning: Misconfiguration on this screen may block network access to the switch's configuration interface.

Providing a reliable time source, such as NTP, is highly recommended, as IKE will reject certificates which are not valid according to the system time, whether it is before the 'not valid before' time or after

the expiration time. If NTP is used, pre-shared keys or hard-wired Security Associations should be used for IPsec communications with the NTP server, or updating the clock will fail.

The HTTPS certificate used by the switch's Web interface cannot be changed on this screen.

12.7.2.1 Switch Certificate

This section may be used to generate or view the details of an X.509 certificate which the switch uses to identify itself via IKE.

A certificate request which can be provided to a third-party CA is also generated. A CA-signed certificate can be uploaded using the form at the bottom of the page and will replace the self-signed certificate used by the switch for IKE. Note that the certificate provided should be generated from the certificate request generated by the switch.

- **Subject**–The DN (distinguished name) identifying the holder of the certificate.
- **Issuer**–The DN (distinguished name) identifying the issuer of the certificate.
- **Serial**–The certificate's serial number.
- **Certificate**–A link which can be used to download the certificate for inspection.
- **Request**–A link which can be used to download a certificate request to be signed by a CA.
- **Not valid before**–The earliest time for which the certificate is valid.
- **Not valid after**–The latest time for which the certificate is valid.
- **Delete**–Pressing this button will delete the certificate and private key, allowing a new one to be generated.

  This operation cannot be undone.

When no IKE certificate is present on the switch, a certificate and key may be generated. The following options may be set.

- **Common Name**–The CN to use as the subject of the new certificate. This should identify the switch and is typically a hostname or IP address. It defaults to the switch's hostname.
- **Bits**–The size of the private key to create, in bits.
- **Expires**–The number of days the certificate will be valid for, starting from the current day according to the switch's clock. This setting is used only for the self-signed certificate; CAs provide their own expiration dates for certificates they produce.

12.7.2.2 IKE Certificates

This section is used to add, delete, and view certificates which are trusted by the switch during IKE negotiation.

- **Subject**–The DN (distinguished name) identifying the holder of the certificate.
- **Issuer**–The DN (distinguished name) identifying the issuer of the certificate.
- **Serial**–The certificate's serial number.
- **Not valid before**–The earliest time for which the certificate is valid.

- **Not valid after**–The latest time for which the certificate is valid.
- **Delete**–Pressing this button will delete the certificate.

Certificates can be added to the switch using the upload form.

- **Certificate Type**–Whether the uploaded certificate is to be used as the switch's identity (“Switch Certificate”), or to be added to the certificates trusted by the switch when negotiating with IKE peers (“CA Certificate”). The CA Certificate option may also be used to trust self-signed certificates from peers.
- **Upload**–The certificate to upload.

12.8 CLI Commands for IPSEC

12.8.1 SPD/SAD Commands

The SPD is the Security Policy Database, used to configure whether encryption, authentication or encapsulation are required for traffic to or from various hosts or ranges of hosts.

The SAD is the Security Association Database, which contains keys used for authentication or encryption between specific hosts.

In general, policies in the SPD will be referred to by their unique (source, destination, direction) tuple. Policies in the SAD will be referred to by their SPI, an index required to be unique on the local host.

1. **`ipsec help`**. Describe the other commands available.
2. **`ipsec spd list`**. List all security policies.
3. **`ipsec spd add <src> <dst> <direction> [esp] [ah] [ipcomp]`**. Add a security policy between the two hosts or host ranges in the given direction (in or out) requiring the specified encapsulations to be used (esp, ah, or ipcomp). If a policy between those two already exists, the specified encapsulations will be added to those in the existing policy.

4. **ipsec spd remove <src> <dst> <direction>**. Remove the security policy between the given hosts, if one exists.
5. **ipsec spd remove all**. Remove all security policies.
6. **ipsec sad list**. List the configured security associations. (Associations added dynamically by IKE will not be included.)
7. **ipsec sad add <spi> <src> <dst> [<cipher>/<key>] [<hash>/<key>] [<compression>]**. Add a Security Association with the given parameters. A cipher or hash algorithm can be specified alone or together, but compression must be alone.
8. **ipsec sad spi <old-spi> <new-spi>**. Change the given policy's SPI.
9. **ipsec sad src <spi> <src>**. Specify a new source host.
10. **ipsec sad dst <spi> <dst>**. Specify a new destination host.
11. **ipsec sad cipher <spi> <cipher> [<key>]**. Update the ESP cipher and key used for this association. (If "disabled" is given as the cipher, ESP will be removed from this association.)
12. **ipsec sad hash <spi> <hash> <key>**. Update the AH hash and key used for this association. (If "disabled" is given, AH will be removed from this association.)
13. **ipsec sad ipcomp <spi> <algo>**. Update the IPComp? algorithm used for this association. Currently "disabled" and "deflate" are the only options.
14. **ipsec sad remove <spi>**. Remove the given SA.
15. **ipsec sad remove all**. Remove all configured security associations.
16. **ipsec sad algos**. List all available algorithms together with the encapsulation they apply to (ESP, AH, or IPComp?) and the allowed key lengths.

12.8.2 IKE Commands

IKE (Internet Key Exchange) provides a way for hosts to automatically negotiate Security Associations using certificates or preshared keys. It acts in two phases; there are a number of options which can apply to specific source and destination hosts in each phase, or act as defaults for a particular phase.

Phase 1 policies are identified by a remote peer identifier; if otherwise unhandled, Racoon falls back to the policy for "anonymous".

Phase 2 policies are identified by a source and destination peer identifier; if the source or destination are otherwise unhandled, Racoon looks for a policy with either source or destination set to "anonymous", and finally for one where both are anonymous.

The ciphers and hash algorithms used will be configured globally for all phase 2 policies. Even though Racoon allows specifying them individually, there is little point since the peers will find the intersection between their supported algorithms automatically.

12.8.2.1 Phase 1 Commands

1. **ike phase1 list**. List all phase 1 configurations for remote peers.
2. **ike phase1 add <address|anonymous>**. Add an entry for a remote section.

3. **ike phase1 preferred_mode <address|anonymous> [<main|aggressive|base>]**
4. ike phase1 mode_main <address|anonymous> [<enabled|disabled>]
5. ike phase1 mode_base <address|anonymous> [<enabled|disabled>]
6. **ike phase1 mode_aggressive <address|anonymous> [<enabled|disabled>]**
7. **ike phase1 address <address|anonymous> [<new address|anonymous>]**. Addresses must be unique.
8. **ike phase1 cipher <address|anonymous> [cipher]**. The cipher may be any of the ciphers supported by Racoon for phase 1.
9. **ike phase1 hash <address|anonymous> [hash]**. The hash may be any of the hashes supported by Racoon for phase 1.
10. **ike phase1 auth_method <address|anonymous> [<pre_shared_key|rsasig>]**
11. **ike phase1 gen_policy <address|anonymous> [<enabled|disabled>]**. Control whether Racoon will automatically generate SPD policies for the remote if none exist already. This is used to support IKE negotiation with peers that require it without requiring it locally.
12. **ike phase1 lifetime <address|anonymous> [new lifetime]**. Lifetime is a number followed by an optional unit: 's' (seconds), 'm' (minutes) or 'h' (hours). If not specified, the unit defaults to seconds.
13. **ike phase1 dh_group <address|anonymous> [new DH group]**. This controls the Diffie-Hellman group used for phase 1 negotiations. Larger groups provide stronger security but introduce a significant computational burden on both peers.

12.8.2.2 Phase 2 Commands

1. **ike phase2 add <address|anonymous> <address|anonymous>**. Add a phase 2 policy.
2. **ike phase2 remove <address|anonymous> <address|anonymous>**. Remove a phase 2 policy.
3. **ike phase2 remove all**. Remove all phase 2 policies.
4. **ike phase2 list**. List all phase 2 policies.
5. **ike phase2 src <address|anonymous> <address|anonymous> [new source address]**. View or set a new source address for the given policy.
6. **ike phase2 dest <address|anonymous> <address|anonymous> [new destination address]**. View or set a new destination address.
7. **ike phase2 pfs_group <address|anonymous> <address|anonymous> [new PFS group|disabled]**. View or set a new PFS group, or disable the use of PFS. The options here are the same as those for ike phase1 dh_group, and the same caveats apply.
8. **ike phase2 lifetime <address|anonymous> <address|anonymous> [new lifetime]**. Sets the lifetime for Security Associations negotiated by phase 2. It takes the same format as ike phase1 lifetime.

12.8.2.3 Algorithm Commands

1. **ike algo list**. View the list of phase 2 algorithms.
2. **ike algo use <algorithm> [enabled|disabled]**. Enable or disable use of a phase 2 algorithm. At least cipher, hash algorithm, and compression algorithm must be enabled at all times.

12.8.2.4 Pre-Shared Key Commands

Pre-shared key commands

The CLI will not know what the key values are until the user sets them. However, existing values are preserved when saving.

1. **ike psk list**. View the list of pre-shared keys.
2. **ike psk add <peer> [<key>]**. Add a new key, possibly with a new value.
3. **ike psk remove <peer>**. Remove the key for a given peer.
4. **ike psk key <peer> [<key>]**. View or set the key for a given peer.

12.8.2.5 Certificate management commands

1. **ike cert bits [bits]**. View or set the number of bits used when generating a certificate.
2. **ike cert days [days]**. View or set the number of days until a generated certificate will expire.
3. **ike cert cn [cn]**. View or set the Common Name used when generating a certificate.
4. **ike cert generate**. Generate a certificate for the switch's use, using the previous three parameters. This operation is performed immediately.
5. **ike cert list**. View all peer and CA certificates.
6. **ike cert mine**. View the switch's certificate.
7. **ike cert remove <filename|"mine”>**. Remove a certificate permanently. This operation is performed immediately.
8. **ike cert put <filename|"mine"|"request"> <url>**. Stores a certificate (or the switch's certificate or certificate request) to the given URL.
9. **ike cert get <"switch"|"peer"> <url>**. Retrieves a certificate (to be trusted for authenticating peers or to identify the switch) from the given URL.

Chapter 13 Using the Command-Line Interface

13.1 Introduction to Command-Line Interface (CLI)

The command-line interface (CLI) is constructed with an eye toward automation of CLI-based configuration. The interaction is modeled on that used in many Internet protocols such as Telnet, FTP, and SMTP. After each command is entered and processed, the switch will issue a reply that consists of a numeric status code and a human-readable explanation of the status. See, for example, the SMTP protocol specification in RFC 821- Simple Mail Transfer Protocol (http://www.faqs.org/rfcs/rfc821.html), specifically, “Appendix E - Theory of Reply Codes.” for more details.

The general format of commands is:

```
section parameter [value]
```

where:

- **`section`** is used to group parameters.
- **`parameter`** will specify the parameter within the section. For example, the network section will have parameters for DHCP, IP address, subnet mask, and default gateway.
- **`value`** is the new value of the parameter. If **`value`** is omitted, the current value is displayed.

Please note that new values will not take effect until explicitly committed.

Sections and parameter names are case sensitive (e.g., “Network” is not the same as “network”).

Note: Any commands in the CLI Commands section of this chapter, with the exception of the global commands, must be prefaced with the name of the section they are in. For example, to change the IP address of the switch, you would type:

```
network address <newIP>
```

This is because the address command is in the network section of this manual.

13.1.1 Accessing the CLI

To access the CLI interface, establish Ethernet or serial connectivity to the switch.

To connect by Ethernet, open a command prompt window and type:

```
telnet <switchip> (where <switchip> is the IP address of the switch)
```

placeholder for screenshot

At the login prompt, type “cli” for the username and “admin” for the password. The switch will respond with “Managed switch configuration CLI ready”.

13.2 CLI Commands

13.2.1 Global Commands

The following global commands are available anywhere in the CLI:

Command	Effect
commit	Values are inter-validated as needed. If valid, values are committed. Please note that this may take some time depending on changes
defaults	Restore factory defaults
quit	CLI is exited. Uncommitted changes are discarded without prompting
reset	Reset the switch
help	Print a help message
prompt	Enable/disable the prompt (usage: “prompt enabled” or “prompt disabled”)

When restoring factory defaults, network settings may be maintained by adding a “savenw” option. In other words:

```
defaults
```

restores all values, but

```
defaults savenw
```

restores all defaults except the current settings for DHCP, IP address, etc.

13.2.2 access Configuration

The following administrative access settings are settable via the CLI:

Parameter	Default	Allowable values
snmp	both	none, snmpv2, snmpv3, both
terminal	both	none, telnet, ssh, both
web	both	non, http, https, both
cli	1	0, 1
uitimeout	0	0-999
rouser	public	Any valid user name
rwuser	private	Any valid user name
ropass	none	A password, followed by the same password repeated
rwpass	None	A password, followed by the same password repeated
adminpass	admin	A password, followed by the same password repeated
fwload	serial	“serial” for serial firmware loading or “network” to enable Ethernet only

13.2.3 alarm Configuration

The following values may be configured in the alarm configuration:

Parameter	Default	Allowable values / Description
list	n/a	No value, view all current alarm settings
powerloss	enabled	'enabled', 'disabled' / alarm output will be low if a power input is lost
ringfailure	disabled	enabled', 'disabled' / alarm output will be low if a power input is lost
These settings require a port number, usage: `alarm <parameter> <port #> [<new value>]`		
linkloss	disabled	'enabled', 'disabled' / alarm output is triggered when link is down on the specified port

13.2.4 modbus Configuration

Parameter	Default	Allowable values / Description
enabled	0	0 or 1, 1 meaning enabled.
stanum	1	1 to 247, used to get or set modbus station number
transport	tcp+udp	tcp / udp / tcp+udp, used to specify allowed trnasport layer for modbus
timeout	0	0 to 3600 or none, time is in seconds
maxcon	4	1 to 20, sets maximum number of concurrent connections
port	502	1 to 65535, set port number to listen for Modbus polling requests

13.2.5 info Configuration

The following values may be read from the info command:

Parameter	Default	Allowable values / Description
fwversion	n/a	View the current firmware version
cfgversion	n/a	View the configuration version number
macaddr	n/a	View the MAC address of the switch
link	n/a	'all', port# / show specified port(s) link status
support	n/a	displays useful support information(IP, etc)
These settings require a filter to be specified: `info <parameter> <filter type> [<value>]`		
mactable	n/a	Filter can be 'id', 'port', 'mac'. See below for syntax

For the **`info mactable`** command, the filter parameters are:

`id={*|#}` Show all/one specific filtering database by ID

`port={*|#[,#[,...]]}` Show all/one/multiple specific port(s)

Note: port 33 is the switch CPU.

`mac={*|xx}:{*|xx}:{*|xx}:{*|xx}:{*|xx}:{*|xx}` Show only MAC addresses matching the given pattern

13.2.6 network Configuration

The switch can have DHCP enabled or disabled. When it is enabled, settings for IP address, subnet mask, and default gateway may still be set. The values will be stored and used should DHCP be disabled in the future.

The following values may be set in the network configuration:

Parameter	Default	Allowable values
dhcp	disabled	enabled, disabled
address	10.2.0.1	Any IPv4 address in dotted decimal notation.
subnet	255.255.0.0	Any IPv4 address in dotted decimal notation.
gateway	none	Any IPv4 address in dotted decimal notation or “none” to indicate no gateway.
hostname	Model id	Any valid Internet host name. See RFC 952 - DoD Internet host table specification (http://www.faqs.org/rfcs/rfc952.html).
dns1	none	Any IPv4 address in dotted decimal notation, or “none”.
dns2	none	Any IPv4 address in dotted decimal notation, or “none”.
domain	“”	A valid Internet domain
ntp	none	Any FQDN (if dns1 or dns2 is set, otherwise any IPv4 address in dotted decimal notation), or “none” to indicate no ntp server.

13.2.7 portsecurity Configuration

The following values may be set in the port security configuration:

Parameter	Default	Allowable values / Description
list	n/a	List all current port security information
enable	n/a	Enables MAC-based port security
disable	n/a	Disables MAC-based port security
add	n/a	Any valid MAC and port number / allow communication my the specified MAC on the specified port
remove	n/a	Any valid MAC / remove a MAC address from the security table

13.2.8 port Configuration

The following values may be set in the port configuration:

Parameter	Default	Allowable values
list	n/a	No value, lists all settings for all ports
monitor	1	Any port number
These settings require a port number, usage: `port <port #> <parameter> [<new value>]`		
name	port_#	A string
admin	enabled	enabled, disabled
negotiation	enabled	enabled (auto-negotiation), disabled (fixed negotiation)
ratelimit	enabled	enabled, disabled
direction	none	none, egress, both
giveip	dis-abled	enabled, disabled
ipaddr	none	An IP address
Sfp	1000	100,1000
speed	(see below)	(see below)

With auto negotiation, <speed> may be:

10H, 10F, 100H, 100F, 1000F, or FC

With fixed negotiation, <speed> may be:

100H or 100F

Valid settings: 'enabled' (will automatically set other speeds to 'disabled')

The syntax for the port speed command is as follows:

```
PORT <PORT #> SPEED …

(negotiation enabled)

speed 10H enabled

speed 10F disabled

...
```

which act like check boxes on a web form.

Or, with negotiation disabled, the syntax is:

```
speed 10H enabled

speed 100F enabled

...
```

which act like radio buttons on a web form.

speed FC enabled/disabled is available in both modes.

For combo ports, the SFP speed may be set as follows:

```
port <port#> sfp <speed>
```

13.2.9 ring Configuration

The following values can be configured in the ring sections:

Parameter	Default	Allowable values / Description
list	n/a	View the list of configured rings
master	auto	'auto', 'this' / configure how the switch determines the ring master
The settings below require a ring number, usage: `ring <parameter> <ring #> [<new value>]`		
enable	0	'0', '1' / view or change whether the ring is enabled
name	n/a	Any text value / View or change the specified ring name
ports	n/a	(see below) / View or change this ring's primary and backup ports

To set the primary and backup ports for a specified ring, the syntax is:

```
ring ports <ring#> <primary port #> <secondary port #>
```

13.2.10 rstp Configuration

The following values may be set in the RSTP configuration:

Parameter	Default	Allowable values / Description
protocol	none	**`none`**, **`stp`**, **`rstp`** or **`mstp`** / View or change the spanning tree protocol
priority	0	A multiple of 4,096 in the range of 0-61440 / View or change the priority

Parameter	Default	Allowable values / Description
mma	6	An integer in the range 6-40 / View or change the maximum message age
hellowtime	1	An integer in the range of 1-10 / View or change the hello time
fwddelay	4	An integer in the range 4-30 / View or change the forwarding delay
Txlimit	1	An integer in the range of 1-10 / View or change the transmission limit
region	n/a	any valid region name
cfgrevision	n/a	any valid revision number
maxhops	20	any number from 6-40
The settings below require a port number, usage: `rstp <parameter> <port #>[<new value>]`		
exclude	0	'2', '1', '0' / View or change whether this port is excluded from STP
pprio	0	An integer in the range of 0-240 / View or change this port's priority
pcost	none	'auto' or integer in the range of 0-200,000,000 / View or change this port's cost
type	1	'1', '0' / View or change this port's edge type
ptp	Auto	'ForceTrue', 'ForceFalce', 'Auto' / View or change this port's point-to-point setting

13.2.11 qos Configuration

The following values may be set in the QoS Configuration:

Parameter	Default	Allowable values / Description
schedule	strict	'strict', 'fair' / View or change the fairness rule
The following require a port number: `qos <parameter> <port#> [<new value>]`		
usetag	1	'0', '1' / View or change whether tag priorities are used
useip	1	'0', '1' / View or change whether IP priorities are used
pref	tag	'tag', 'ip' / View or change which to use if both tags and IP are enabled

Parameter	Default	Allowable values / Description
priority	1	0-3 / Default priority to give to packets received on this port
type	normal	'normal', 'add', 'remove', 'double' / The type of connection to this port
The following require a tag number: `qos tag<tag #> [<new value>]`		
tag	(depends on the tag)	0-3 / View or change the priority of the specified tag

If <new value> is not present, the current setting will be displayed.

13.2.12 vlan Configuration

The following values may be set in the VLAN Configuration:

Parameter	Default	Allowable values / Description
vlist	none	No value, lists all configured VLANs
plist	none	No value, lists the VLAN settings for each port
mode	dis-abled	'disabled', 'port', 'standard', 'secure' / View or change VLAN mode
coretype	none	Value in hexadecimal with a 0x prefix / View or set Ethertype for core tags
mgmtvlan	1	1-4094 / View or set the management VLAN ID
learning	shared	'shared', 'independent' / Change VLAN learn-ing mode
mgmtports	all	1-9 / View or set the management VLAN port
The commands below require a vlan # from vlist.		
name	n/a	A string of no more than 33 characters
vtype	n/a	'port', 'tag' / View or change the type of this VLAN
id	n/a	An integer between 1 and 4094 / View or change the ID of this VLAN
ports	n/a	Syntax: vlan ports <vlan#> <add/remove> <port#>
The commands below require a port #		
pvid	1	A VLAN # from vlist valid range of 1-4094
force	0	'0', '1'

Parameter	Default	Allowable values / Description
add	(see below)	(see below)
remove	(see below)	(see below)

The examples below explain the syntax of the “port”, “add” and “remove” commands:

To add a Port Based VLAN:

```
vlan ports <vlan #> add <port #>

vlan ports <vlan #> remove <port #>

vlan add <name> port <port #> <port #> [...]
```

To add a Tag based VLAN:

```
vlan add <name> tag <vlan ID> <port #> <port #> [...]
```

To remove a VLAN:

```
vlan remove <vlan # or all>
```

13.2.13 igmp Configuration

The following commands may be used to configure IGMP:

Parameter	Default	Allowable values / Description
rlist	n/a	No value/ Lists router settings for all ports
mode	disabled	disabled, snoop, router / view or change IGMP mode
msupp	none	none, ip, all / view or change the multi-cast suppression method
version	2	1, 2 / IGMP version
robustness	2	1-99 / IGMP robustness
qinterval	125	60-125 / IGMP query interval
qresponse	10	1-30 / IGMP query response interval
The commands below require a port number:		
router	0	0, 1 / identify ports which lead to IGMP routers
exclude	0	0, 1 / Exclude a port from the processing of IGMP requests and queries

13.2.14 chkpt Configuration

The following values may be set in the checkpoint configuration:

Parameter	Default	Allowable values / Description
save	n/a	None / saves a checkpoint
restore	n/a	net, nonet / net saves current network settings, nonet discards them
ftpsave	n/a	A file name
ftprestore	n/a	A file name

13.2.15 firmware Configuration

Parameter	Default	Allowable values / Description
default	n/a	1 or 2, view or change the default firmware
running	n/a	view which firmware image is running
list	n/a	view list of currently available firmware images and corresponding health status
update	n/a	followed by **[showProgress] [md5=<md5>] <url>** If the 'showProgress' argument is provided, progress printouts will be displayed. If the 'md5' argument is provided, the MD5 checksum of the received firmware will be tested against the provided md5 checksum the URL must be a valid HTTP or HTTPS address to which the switch has direct access.
ftpload	n/a	followed bhe flename to be uploaded from teh TFTP server

13.2.16 tftp Configuration

The following options can be set in TFTP configuration:

Parameter	Default	Allowable values
tftp	“”	A valid fully-qualified domain name

13.2.17 tz Configuration

The following values may be set in Timezone configuration:

Parameter	Default	Allowable values
list	(see below)	(see below)
value	none	A time zone from list

Note: To view a list of all timezones, use the command "tz list [<prefix>]" with the option to filter by timezones beginning with the characters in <prefix>.

13.2.18 msti Configuration

Parameter	Default	Allowable values
list	n/a	lists all MSTIs and their priorities
plist	n/a	followed by **mstid**, used to show all ports in the specified MSTI with their costs and priorities
add	n/a	followed by **name mstid [priority]**
remove	n/a	any valid MSTI, or **all** to remove all MSTIs
priority	32768	followed by **mstid [priority]**
pprio	varies	followed by **mstid portno [pprio]**,used for per-MSTI port priorities
pcost	varies	followed by **mstid portno [pcost]**,used for per-MSTI port costs
name	n/a	followed by **mstid [name]**
mstid	n/a	followed by **mstid [newmstid]**
inherit	n/a	any valid MSTI. used to inherit from the CIST

13.2.19 General Configuration

The following commands are general commands which are not part of another subsection:

Command	Default	Allowable values / Description
location	<set location of switch>	Any text value / location of the switch
contact	<set name (and email) of contact for switch>	Any text value / contact information of the network or site administrator

13.2.19.1 Example Configuration Session

In the following example, bold text is sent by the switch and normal text is entered by the user. Upon connection to the serial port of the switch, a login banner and prompt are displayed.

Note: Logging into this software acknowledges that you have agreed to abide by the software license as stated in the user manual.

```
Switch login: cli

Password: <hidden>

210 Managed switch configuration CLI ready.

network dhcp

212 Current dhcp setting is 'disabled'

network address 192.168.1.1

112 address set to '192.168.1.1'

network hostname switch-1

112 hostname set to 'switch-1'

rstp protocol rstp

113 protocol set to 'rstp'

info link all

219-List of link status
```

Port#	Name	Link
1	port_1	down
2	port_2	down
3	port_3	100f
4	port_4	down
5	port_5	down
6	port_6	down
7	port_7	down
8	port_8	down

```
219 List of link status

info fwversion

219 Current fwversion setting is '4.4'

vlan mode standard

117 mode set to 'standard'

vlan mgmtports
```

```
217 Current mgmtports setting is 'C 1 2 3 4 5 6 7 8'

commit

210 Values committed.

quit

210 Managed switch configuration CLI done.
```

After quit, the CLI program will exit and the session will terminate. A login banner and prompt will be presented again.

Please note that there may be a delay of up to a minute between the commit command and the CLI's response. This is normal.

Appendix A Licensing and Policies

This appendix gives licensing and policy information for Sixnet products.

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Appendix B Regulatory Statements

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Appendix C Default Software Configuration Settings

C.1 About Default Settings

The settings below are the factory defaults when the switch comes out of the box. Use this page as a reference for tailoring the switch to your needs.

C.1.1 Management Port

- DHCP: disabled
- IP Address: 10.2.0.1
- Subnet Mask: 255.255.0.0
- Default Gateway: none
- NTP: Disabled
- Timezone: GMT

C.1.2 Port Configuration for Ports 1-9

Port	Name	Admin	Mode	Speed & Duplex	Flow Control
1	Port_1	Enabled	Auto	10h 10f 100h 100f	Disabled
2	Port_2	Enabled	Auto	10h 10f 100h 100f	Disabled
3	Port_3	Enabled	Auto	10h 10f 100h 100f	Disabled
4	Port_4	Enabled	Auto	10h 10f 100h 100f	Disabled
5	Port_5	Enabled	Auto	10h 10f 100h 100f	Disabled
6	Port_6	Enabled	Auto	10h 10f 100h 100f	Disabled
7	Port_7	Enabled	Auto	10h 10f 100h 100f 1000f	Disabled

Port	Name	Admin	Mode	Speed & Duplex	Flow Control
8	Port_8	Enabled	Auto	10h 10f 100h 100f 1000f	Disabled
9	Port_9	Enabled	Auto	10h 10f 100h 100f 1000f	Disabled

C.1.3 Port Mirroring

Mirroring: Disabled

C.1.4 RSTP/STP Configuration

- Redundancy Protocol: none (spanning tree protocol is disabled)
- Bridge Priority: 32768
- Max. Age: 20
- Hello Time: 2
- Forward Delay: 15
- Transmission Limit: 6

C.1.5 RSTP/STP Port Configuration

Port	Name	R(STP)	Priority	Cost	Type	PtpMAC
1	Port_1	Included	128	200000	Auto	Auto
2	Port_2	Included	128	200000	Auto	Auto
3	Port_3	Included	128	200000	Auto	Auto
4	Port_4	Included	128	200000	Auto	Auto
5	Port_5	Included	128	200000	Auto	Auto
6	Port_6	Included	128	200000	Auto	Auto
7	Port_7	Included	128	200000	Auto	Auto
8	Port_8	Included	128	200000	Auto	Auto
9	Port_9	Included	128	200000	Auto	Auto

C.1.6 SNMP Notifications

All traps disabled.

C.1.7 IGMP Settings

- IGMP Mode: Disabled
- Multicast suppression: None
- IGMP Version: 2

- Robustness: 2
- Query Interval: 125 seconds
- Query Response Interval: 10 seconds
- Static Router: Disabled for all ports

C.1.8 Trap Managers

No trap managers configured.

C.1.9 Priority Queuing

- Use 802.1p Tag Priority: Enabled
- Use IP ToS/DiffServ: Enabled
- Priority Precedence: Tag
- Default Priority: Normal
- Type: Transparent
- QoS Scheduling: Strict

C.1.10 SNMP System Information

- Contact: <Set name (and e-mail) of contact for switch>
- System Name: Managed Switch
- Location: <Set location of switch>

C.1.11 Remote Access Security

- SNMP Access: both SNMPv2 and v3 enabled
- Terminal Access: both SSH and telnet enabled
- Web Access: both http and https enabled
- Inactivity logout: 5 minutes
- SNMP Read-only Name: public
- SNMP Read-only Password: publicpwd
- SNMP Read/write Name: private
- SNMP Read/write Password: privatepwd
- Admin Password: admin

C.1.12 IEEE Tagging

Priority	Traffic Type	Queue
0	Best Effort	1
1	Background	0
2	Spare	0
3	Excellent Effort	1
4	Controlled Load	2
5	Video	2
6	Voice	3
7	Network control	3

C.1.13 VLAN Mode

Disabled

C.1.14 VLAN Port Settings

Port	PVID	Force	Type
1	1	Disabled	Transparent
2	1	Disabled	Transparent
3	1	Disabled	Transparent
4	1	Disabled	Transparent
5	1	Disabled	Transparent
6	1	Disabled	Transparent
7	1	Disabled	Transparent
8	1	Disabled	Transparent
9	1	Disabled	Transparent

C.1.15 Modem Settings

- Auto-answer rings: 2
- Comma delay: 1
- Speed: MAX
- Data Compression: Both
- Error Correction: Enabled
- Custom initialization: Blank

- Digital output meaning: Power OK

C.1.16 PPP Settings

- PPP Mode: Disabled
- User name: PPPLink
- User phone number: Blank
- Password: Link2Sixnet
- Idle Timeout: 60 seconds
- Default route: Enabled
- Server calls back: Disabled
- Switch's phone number: Blank
- Client IP: Blank
- Route to Gateway: Disabled

C.1.17 Remote Users

All users are Disabled.

C.1.18 Routing

- PPP Rip mode: Disabled
- PPP Send: RIP v1
- PPP Receive: RIP v1
- LAN Rip mode: Disabled
- LAN Send: RIP v1
- LAN Receive: RIP v1

C.1.19 Dial-Out Messaging

Digital input action: Disabled

Primary phone number: Blank

Secondary phone number: Blank

Number Selection: Alternate

Retry Limit: 2

Retry delay: 120 seconds

Message type: Numeric

Message: Blank

Send Message delay: 2 seconds

ACK Message: Blank

Message resend limit: 2

Message resend delay: 2 seconds

Appendix D SNMP Support

Groups	General Description	Location and RFC	Support
System	Information about the switch as a system: name, description, physical location, uptime, contact, and a list of other groups in the MIB.	1.3.6.1.2.1.1 RFC 1213	This MIB is fully supported
Interfaces	Per-port information at the interface layer.	1.3.6.1.2.1.2 RFC 1229	ifTable: Basic interface info. ifXTable: Extended interface info. ifStackTable: Interface layering (for VLANs).
AT	Address translation information to map IP addresses to MAC addresses.	1.3.6.1.2.1.3 RFC 1213	This MIB is fully supported.
IP	Information used to keep track of the IP layer on the managed node.	1.3.6.1.2.1.4 RFC 2011	This MIB is full supported.
TCP	Information to keep track of the application entities using TCP.	1.3.6.1.2.1.6 RFC 2012	This MIB is supported but keep in mind that this is a host oriented MIB so it may not be particularly helpful to you.
UDP	Information to keep track of application entities using User Datagram Protocol.	1.3.6.1.2.1.7 RFC 2013	This MIB is supported but keep in mind that this is a host oriented MIB so it may not be particularly helpful to you.

Groups	General Description	Location and RFC	Support
Dot3	Performance statistics for "Ether-like" devices.	1.3.6.1.2.1.10.7 RFC 2665	This MIB is fully supported.
SNMP	Statistical information about the SNMP protocol entity and tracks the amount of management traffic that a device responds to.	1.3.6.1.2.1.11 RFC 1213	This MIB is fully supported.
RMON	Remote Monitoring	1.3.6.1.2.1.16 RFC 1757	Group 1: Ethernet statistics. Group 2: Ethernet history (8 samples each at 30 second and 30 minute intervals for each port).
Dot1dBridge	STP/RSTP MIB	1.3.6.1.2.1.17 RFC 1493	dot1dStpPortTable: Spanning Tree protocol info. dot1dTpFdbTable: Learned MAC addresses and port associations. dot1dTpPortTable: Port info similar to RMON.
Dot1dBase	Basic STP/RSTP information.	1.3.6.1.2.1.17.1 RFC 1493	This MIB is fully supported.
Dot1dStp	Spanning Tree Protocol operating parameters	1.3.6.1.2.1.17.2 RFC 1493	This MIB is fully supported.
Dot1dTp	Transparent routing parameters and performance.	1.3.6.1.2.1.17.4 RFC 1493	This MIB is fully supported.
Dot1qBridge	VLAN MIB	1.3.6.1.2.1.17.7 RFC 2674	This MIB is fully supported.
IGMPStdMIB	IGMP MIB	1.3.6.1.2.1.85 RFC 2933	This MIB is fully supported for all things relevant.
ETxMS	Switch specific data (private MIB)	1.3.6.1.4.1.20540.2.1	This MIB is fully supported. See below.

- For the latest Sixnet MIB text file please go to: http://www.sixnet.com

Appendix E Concepts and Definitions

10/100BASE-Tx, 100BASE-FX, 1000BaseT/F	This describes the type of port. 10BASE-T is a 10 Mbps copper (RJ45) port, 100BASE-TX is a 100 Mbps copper port, 100BASE-FX is a 100 Mbps fiber optic port and 1000BaseT/F is 1000 Mbps copper or fiber port.
Active Communication	Communication is enabled between two devices with no hindrances (such as a port in a blocked state). As long as there is only ONE active communications path from a root to any end node, there will be no loops in the active topology.
Auto-MDI/MDIX-Crossover	The RJ45 (copper) ports on the switch will automatically detect the cable type (straight-thru vs. cross-wired) and re-configure themselves accordingly.
Auto-Polarity	The RJ45 (copper) ports on the switch will intelligently correct for reverse polarity on the TD and RD pair.
Auto-Sensing or Auto-Negotiation	The RJ45 (copper) ports on the switch will intelligently detect the speed (10BASE-T - 10 Mbps or 100BASE-TX - 100 Mbps) and duplex (half or full). The fiber ports are fixed at 100BASE-FX and the duplex is settable.
BPDU	Bridge Protocol Data Unit: These data units are used to keep bridges informed of the network status.
Bridge Priority	A setting that helps create the hierarchical levels as to which switch will become root.
Bridge	Device used as a means to connect/communicate between two networks. Also called a “switch”.
CoS	Class of Service is a method to prioritize the network traffic based on the traffic type. (See also QoS, ToS, Traffic class.)
Designated Bridge	Each managed bridge is designated to the LANs for which it is connected to (via its designated ports). For the root bridge, it is designated to all the LANs in the managed network.
DHCP	Dynamic Host Configuration Protocol: This is a protocol used to assign IP addresses in a network. The device that uses this protocol to gain access to the network obtains a dynamically changing IP address such that it could have a different IP address every time.

DNS	Domain Name Server: This server translates domain names into IP addresses.
Duplex (full or half)	Half duplex means that messages flow in only one direction at a time. Full duplex means that messages flow in both directions at the same time. The RJ45 ports of the switch automatically support (auto-sense) both full and half duplex flow control. The fiber optic port is software configurable for full or half duplex flow control.
Edge Port	A port that is only linked to an end station and cannot create a loop in the network.
Forward Delay	Time used in STP to wait before determining it is safe for a port to make transitions leading to forwarding network traffic.
Full Duplex	Simultaneous transmission of data in both directions across one link.
Gateway IP	IP address of the device used to bring two networks together.
GDA	Group Destination Address. A class D IP address used as the destination address for multicast data. Class D IP addresses have high-order bits 1110 and fall in the range 224.0.0.0 to 239.255.255.255.
Half Duplex	Only one device is transmitting data at any point in time.
Hello Timer	Timer value to indicate the interval that STP configuration messages are sent out from the root bridge.
IEEE 802.3	This is the primary standard for Ethernet. This switch complies with this primary standard and various related sub standards such as 802.3u (100BASE-TX), 802.3x (full-duplex with flow control), 802.1D-2004 (STP, RSTP)
IEEE 802.1Q	This switch complies with this standard for the operation of Virtual LANs.
IGMP	Internet Group Management Protocol used for IP multicast filtering.
IP Address	Address used to indicate the destination of where IP packets should go.
IPv4	Internet Protocol version 4.
IPv6	Internet Protocol version 6.
Latency	This is the time it takes a message to be routed internal to a switch from one port to another. The typical latency of a message is 5 microseconds (@ 100 Mbps) or faster.
MAC Address	Each Ethernet device inserts its unique “MAC” address into each message it sends out. The port on the switch used for a given MAC address is automatically learned when a frame is received from that address. Once an address is learned, the switch will route messages to only the appropriate port, instead of broadcasting messages out all ports like a hub. A time stamp is also placed in memory when a new address is learned. This time stamp is used with the aging feature, which will remove unused MAC addresses from the table after 300 seconds. If a device moves, the associated port on the switch will be changed (migrated) as needed. Up to 2,048 MAC addresses can be stored and monitored at any time.

Managed Switch	A device that forwards packets between LANs. This device also has to capability to support loop configurations using Spanning Tree Protocol. Loop configurations are used to prevent a single point of hardware failure in a network. Management Information about the network is also obtained through the switch by querying the MIB
Multicast	A means of sending messages to multiple hosts without broadcasting the data to all hosts or sending it individually to each interested host. IGMP may be used to optimize routing of multicast messages so only network segments with interested hosts need carry multicast traffic.
Max Message Age	Length of time the STP Algorithm waits before reconfiguration is necessary.
MIB	Management Information Base: This is a database of objects that is used by some form of network management system (like the managed switch). SNMP and RMON are popular tools to obtain the information from the MIB.
Mirroring	This diagnostic capability allows messages from one or more source ports to be copied to one or more target (monitor) ports. Then a port analyzer or "sniffer" program can be used to monitor the traffic without affecting the operation of the switch.
Notification	See "Trap".
Path Cost	For each pathway a packet of information must pass, there is an associated cost. A number is used to indicate the cost from a source port to a destination port. The lowest number (least cost) among a set of paths from a specific source and destination will be chosen as the optimal path of choice.
PPP	Point-to-Point Protocol. Allows a serial connection to be used as if it was a low-speed network connection.
Point to Point MAC	This indicator is used to optimize the convergence time in the STP algorithm.
Port Priority	A numeric value placed upon a port to indicate its hierarchical standing to become a designated port.
QoS	Quality of Service. Generic description of network service parameters such as latency, frame loss, user priority, etc. (See also CoS, ToS.)
RMON (Remote Monitoring)	This network management protocol allows access to a richer MIB to provide more extensive and detailed information about the network.
Root Bridge	The bridge that controls the Spanning Tree Topology.
Root Port	This port that provides the connection (directly or indirectly) to the root bridge.
RSTP	Rapid Spanning Tree Protocol: This protocol is an improvement over the original STP technology, providing for faster convergence times.
SNMP	Simple Network Management Protocol: Protocol used to manage complex networks. A computer/device requests data from SNMP agents through protocol data units. The agents return the data that is stored in their MIBs (Management Information Bases).

SNMP Agent	The software which monitors the status of a device such as the managed switch and provides information about that status to clients by replying to requests or sending notifications.
Store & Forward	This is the standard operating mode for the switch.
STP	Spanning Tree Protocol: This protocol is used to prevent loops in a bridged network, but still allowing for redundant connections as a safe guard against single points of hardware failure.
Subnet	A subnet is the part of the network that shares the same part of an IP address. For security reasons, a network can be divided into many subnets by using a subnet mask. The subnet mask setting in devices is combined with the binary IP address to extract the subnet ID. On an IP network, only devices with the same subnet ID can communicate with each other.
Telnet	This is a terminal emulation program used to access a telnet server. Once connected and logged in to the telnet server, commands can be remotely executed as if the user were at the server him/herself.
ToS	Type of Service. A field in the IPv4 header which specifies the type of service requested in handling the packet. The value may be from 0 to 255. (See also CoS, QoS.)
Traffic Class	A field in the IPv6 header which specifies the relative priority of the frame. The value may be from 0 to 255.
Trap	A message sent by an SNMP agent to an SNMP trap manager to notify the manager of a change in the state of the device monitored by the agent. Examples of traps include cold start (the device is turned on), authentication failure (a user supplied invalid credentials when attempting to connect to the agent), and link up/down (a connection to a port was made or broken).
VLAN	VLANs segregate traffic flowing through a switch to improve bandwidth utilization or security. Segregation is done based on membership in a group of ports (port-based VLANs) or on IEEE 802.1Q tags which include a VLAN ID (tag-based VLANs). Devices on one VLAN can not talk to devices on another VLAN unless a router is involved to join them.

Appendix F AT Command Summary (-MDM Models Only

F.1 AT Commands

The AT commands defined in this section can be entered to configure the modem for advanced applications in the Modem Settings configuration screen.

%C - V.42bis Data Compression	n=0 Data Compression Disabled * n=1 Bidirectional Data Compression n=2 Data Compression Transmit Only n=3 Data Compression Receive Only
\Nn - Error Control Mode	n=0 Normal Mode n=2 MNP Required n=3 V.42 auto reliable mode * n=4 LAPM required for connection n=5 V.42 or MNP required
&Z - Sleep Mode	Wake on incoming Ring

F.2 S-Registers

The S-Registers defined in this section can be entered to configure the modem for advanced applications in the Modem Settings configuration screen.

S0 - Answer on nth Ring:

S0 sets the modem to automatically answer on the nth ring.

Setting S0 to 0 disables automatic answer.

Range: 0 to 255
Units: Rings
Default: 0

S1 - Ring Count:

S1 is a read-only register showing the number of rings detected. If no ring is detected within 8 seconds, S1 is reset.

Range: 0 to 255
Units: Rings
Default: 0

S6 - Dial Tone Wait Time:

S6 determines how long the modem waits for dial tone before dialing. The Dial Tone Wait Time cannot be set to less than two seconds.

Range: 0 to 255
Units: Seconds
Default: 2

S7 - Wait for Carrier after Dialing:

S7 determines how long the modem waits for a valid carrier signal after dialing.

Range: 0 to 255
Units: Seconds
Default: 80

S8 - Comma Pause Time:

S8 defines the duration of the pause initiated by a comma in the dialing string. The pause is generally used when waiting for a second dial tone.

Range: 0 to 255
Units: Seconds
Default: 2

S9 - Carrier Detect Response Time:

S9 establishes the length of time the remote modem's carrier must be present to be

recognized as valid.

Range: 1 to 255
Units: 0.1 Seconds
Default: 6

S10 - Carrier Off Disconnect Delay:

S10 selects how long carrier must be lost before the modem disconnects. If S10 is smaller than S9 or S10 is set to 255, the modem will not disconnect on any loss of carrier.

Range: 1 to 255
Units: 0.1 Seconds
Default: 14

S14 - Wait for Dial Tone Delay:

S14 determines how long the modem will wait for dial tone when the W dial modifier is used.

Range: 0 to 255
Units: Seconds
Default: 12

S24 - Sleep Inactivity Timer:

S24 sets the length of inactivity before the modem enters sleep mode. Zero disables sleep mode.

Range: 0 to 255
Units: Seconds
Default: 0

S30 - Disconnect Inactivity Timer:

S30 sets how long the modem remains on line with no data flowing. Zero disables the timer.

Range: 0-255
Units: Minutes
Default: 0

S38 - Hang Up Delay Timer:

S38 determines the maximum delay between receipt of the ATH0 command and modem disconnect.

Range: 0-255
Units: Seconds
Default: 20

S50 Minimum Off-Hook Duration:

S50 determines the minimum length of time the modem will remain off-hook. An attempt to drop the line before this timer expires will be ignored by the modem.

Range: 0-255
Units: Seconds
Default: 3

Appendix G Service Information

We sincerely hope that you never experience a problem with any Sixnet product. If you do need service, call Sixnet at (518) 877-5173 and ask for Applications Engineering. A trained specialist will help you to quickly determine the source of the problem. Many problems are easily resolved with a single phone call. If it is necessary to return a unit to us, an RMA (Return Material Authorization) number will be given to you.

Sixnet tracks the flow of returned material with our RMA system to ensure speedy service. You must include this RMA number on the outside of the box so that your return can be processed immediately.

The applications engineer you are speaking with will fill out an RMA request for you. If the unit has a serial number, we will not need detailed financial information. Otherwise, be sure to have your original purchase order number and date purchased available.

We suggest that you give us a repair purchase order number in case the repair is not covered under our warranty. You will not be billed if the repair is covered under warranty.

Please supply us with as many details about the problem as you can. The information you supply will be written on the RMA form and supplied to the repair department before your unit arrives. This helps us to provide you with the best service, in the fastest manner. Normally, repairs are completed in two days. Sometimes difficult problems take a little longer to solve.

If you need a quicker turnaround, ship the unit to us by air freight. We give priority service to equipment that arrives by overnight delivery. Many repairs received by mid-morning (typical overnight delivery) can be finished the same day and returned immediately.

We apologize for any inconvenience that the need for repair may cause you. We hope that our rapid service meets your needs. If you have any suggestions to help us improve our service, please give us a call. We appreciate your ideas and will respond to them.

For Your Convenience:

Please fill in the following and keep this manual with your Sixnet system for future reference:

P.O. #:_____ Date Purchased: _____

Purchased From:_____

G.1 Product Support

To obtain support for Sixnet products:

On-line support: http://www.sixnet.com
Phone: (518) 877-5173
Fax: (518) 877-8346
Latest product info: http://www.sixnet.com
E-mail: mailto:support@sixnet.com
Mailing address: Sixnet Technology Park, 331 Ushers Road, Ballston Lake, NY 12019

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The following is a list of the license agreements of the software and libraries used in the development of the firmware.

To obtain the source code for all the software and libraries listed in this appendix, email Sixnet at: support@sixnet.com.

H.1 PCRE Library

PCRE is a library of functions to support regular expressions whose syntax and semantics are as close as possible to those of the Perl 5 language.

Release 8 of PCRE is distributed under the terms of the "BSD" licence, as specified below. The documentation for PCRE, supplied in the "doc" directory, is distributed under the same terms as the software itself.

The basic library functions are written in C and are freestanding. Also included in the distribution is a set of C++ wrapper functions.

THE BASIC LIBRARY FUNCTIONS

Written by: Philip Hazel
Email local part: ph10
Email domain: cam.ac.uk

University of Cambridge Computing Service,
Cambridge, England.

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THE C++ WRAPPER FUNCTIONS

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This is the Debian packaged version of ipsec-tools.

Sources for this package can be found at its homepage at: http://ipsec-tools.sourceforge.net/.

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